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Guidelines for the Development of Military Training Decision Aids

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A literature review was conducted to examine issues involved in establishing training situations/levels and selecting media. Additionally, 23 existing decision aids for determining training situations/levels and selecting training media were examined and critiqued. Major issues involved in determining training situations/levels and selecting training media were identified, and training decision aids included in the review were characterized and compared on these issues. Finally, recommendations were established for developing training decision aids tailored to military requirements. Keywords

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FOREWORD

This research and development was conducted within Marine Corps Air-Ground Technology Program Element No. 62131M under the Training Technology Project No. CF31T33, Task Area 01 and under the sponsorship of Headquarters, United States Marine Corps, Code TAP.

The objective of this effort was to provide recommendations for the development of military training decision aids. This report examines and critiques 23 existing training decision aids and identifies major issues involved in determining training situations/levels and selecting training media.

The report is intended for the use of instructional developers and managers.

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SUMMARY

Objectives

The objectives of this effort were to: (1) examine major issues involved in the establishment of training situations/levels and the selection of training media, (2) review and compare the characteristics of decision aids developed to assist training managers, developers, and other users to establish training situations/levels and select training media, and (3) provide recommendations for the development of training decision aids oriented to military training requirements.

Background

The military's System Approach to Training includes requirements for specification of the situations/levels at which training is to take place and the appropriate training media. At present, such specifications must often be made without adequate guidance and documentation. As a result, important factors can be overlooked in the decision process. Additionally, it is often difficult to track and record the decision process for such specifications in order to justify decisions or evaluate decision criteria.

Problems

A wide variety of training decision aids are now available to assist military decision makers in determining training situations/levels and selecting training media. Analyses of these aids are needed to determine the appropriateness of their formats and procedures.

Approach

First, publications examining the effectiveness of training decision aids were reviewed and existing training decision aids were analyzed. Second, major issues involved in determining training situations/levels and selecting training media were identified. Existing training decision aids were characterized and compared with respect to these issues. Third, recommendations were developed for tailoring training decision aids to meet the needs of military users.

Findings and Conclusions

1. Most existing training decision aids have not been found to be effective in aiding personnel to select training situations/levels or media.

2. Desirable attributes for military training decision aids can be identified and justified from reviews of current research and examinations of existing aids.

3. Existing decision aids for determining relataive costs of training paths and refresher training requirements appear to be effective adjuncts to aid in the process of establishing training situations/levels.

4. None of the reviewed aids satisfy all of the required attributes identified in this report. However, many existing training decision aids contain desirable criteria that could be incorporated into more effective aids that would be suitable for military requirements.

5. Methods for designing more effective military training decision aids that incorporate desirable selection criteria are needed.

Recommendations

These recommendations provide a basis for guiding the design and development of military training decision aids that can be used to improve the quality of training decisions and provide cost/effective training programs.

1. Develop training decision aids for specific military applications.

2. Combine computerized flowcharts and matrix formats in structuring decision aids.

3. Provide detailed guidance for decision makers.

4. Develop training decision aids for specific types of tasks.

5. Select training situations/levels based on task prerequisites, training priorities, available training time, task appropriateness, and training costs.

6. Use existing situation/level decision aids for determining relative costs and refresher training intervals.

7. Select training presentation methods based on training location, group characteristics, training events, stimulus characteristics, affective (motivational) requirements, level of difficulty, programming requirements, group practice, simulation requirements, and requirements for automation of testing and data management.

8. Select training media based on training presentation methods; requirements for modification, mobility, and development time; costs; availability; and instructor preference.

9. Consider a combination of training presentation methods and media for teaching each task.

CONTENTS

INTRODUCTION

Background

In accordance with the Systems Approach to Training (SAT), military training organizations are adopting systematic approaches to training development. These approaches include specifying the training situations/levels at which training is to take place and selecting appropriate training media. Situation/level specifications indicate where the training should be provided (in formal schools or at unit commands), when it should be provided (during preliminary, advanced, or refresher training), and who should receive the training (what occupations, grade levels, and, where appropriate, levels of maintenance responsibility). Training media specifications indicate the media delivery systems that should be used for specific types of training situations/levels, methods, and content.

At present, military decision makers must often determine training situations/levels and select training media without benefit of systematic consideration and documentation of the many factors that influence training decisions. As a result, important factors may be excluded from the decision process. Additionally, without a systematic procedure, it is often difficult to track and record the decision process to justify the decisions or to evaluate the appropriateness of the decision criteria.

Objectives

The objectives of this effort were to:

1. Examine major issues involved in the establishment of training situations/levels and the selection of training media.

2. Review and compare the characteristics of decision aids developed to assist training managers, developers, and other users to establish training situations/levels and select training media.

3. Provide recommendations for the development of effective training decision aids oriented to military requirements.

Problems

A wide variety of training decision aids are now available to assist military decision makers in determining training situations/levels and selecting training media. However, no analyses of these aids have been conducted to determine the appropriateness of their formats and procedures.

APPROACH

Method

This effort started with a review of (1) publications on the effectiveness of training decision aids and (2) existing decision aids for determining training situations/levels and selecting training media. Next, the major issues involved in determining training situations/levels and selecting training media were identified. Existing training decision

aids were characterized and compared with respect to these issues. Finally, recommendations were developed for tailoring training decision aids to meet the needs of military users.

Review Orientation

The present review of decision aids for establishing training situations/levels and selecting training media differs from previous reviews in a number of ways. First, previous reviews have only dealt with decision aids for media selection and have paid relatively little attention to aids for determining training situations/levels.

Second, past reviews have typically been organized either in terms of the media characteristics the aids deal with (Reiser & Gagne, 1982) or in terms of the media selection aids themselves (Heidt, 1978; Levie, 1977). Both forms of organization have some merit. A consideration of media characteristics provides a basis for discussing what features are beneficial to a decision aid. A description of individual decision aids facilitates the determination of how the various characteristics are incorporated into each aid and allows potential users to decide which type of decision aid might be most beneficial for their particular requirements. Therefore, this report provides both forms of organization. Characteristics of training decision aids are discussed in the body of this report and each decision aid is described in detail in Appendix A.

Third, in attempting to characterize media selection issues, past reviews have typically confounded presentation methods with media. The distinction between presentation and media is considered to be a critical factor in media selection and is maintained in the present review.

Fourth, in reviewing training decision aid characteristics, past reviews were often noncommittal on the value of the various approaches that were taken in developing decision aids. This report attempts to assess the value of these different approaches in order to provide a basis for recommendations for the development of training decision aids.

Fifth, the review emphasizes training decision aids and related issues that are relevant to military users.

Report Organization

The next section presents research findings on the effectiveness of training decision aids, discusses the characteristics of existing aids, critiques the appropriateness of different formats and criteria used in these aids, and provides recommendations for developing effective training decision aids for military users.

Summary descriptions of existing training decision aids referenced in this report are presented in Appendix A. A cross-reference to training decision aids recommended for use or as examples is provided in Appendix B.

A glossary of special terms used in this report is provided on page 29.

FINDINGS AND DISCUSSION

Effectiveness of Training Decision Aids

Research Findings

From an initial exploration of the research findings, one finds little support for the use of training decision aids. With respect to decision aids for establishing training situations/levels, no studies have been conducted to determine their effectiveness. With respect to decision aids for media selection, the results of experimental evaluations have been mixed.

The most extensive evaluation of media selection aids was conducted by Braby (1973). In Braby's study, the subjects selected media for a specific course content based on one of nine media selection models or based on their own independent opinions. Each of the models (including independent opinions) was then rated by two evaluators based on their subjective judgments of the effectiveness of the resulting media decisions. While some models received higher ratings than others, none received higher ratings than were given to independent opinions. None of the evaluated media selection aids produced more effective media choices than were made without aids.

Braby's negative findings can be questioned in terms of the expertise of the subjects who used the decision aids. Five of Braby's six subjects were experienced in training system design. A knowledgeable user who is already familiar with a wide range of instructional methods and media and their proper applications might not benefit from guidance as much as would a less sophisticated decision maker.

This position was supported in a later study by Higgins and Reiser (1985). The authors randomly assigned one of four different media design problems to each of 22 inexperienced graduate students. First, the students selected the best medium or media for the assigned design problem based on their intuition. Next, the students reviewed an article describing characteristics of media selection models (Reiser & Gagne, 1982) and a portion of a text on the use of a media selection flowchart designed by Reiser and Gagne (1983). Again, each student was randomly assigned one of the four media design problems and required to select the best medium or media. Two instructional designers with "considerable design experience" had previously identified the "correct" media solutions for the four design problems. Results indicated that, 17 percent of the students who used their intuition chose only the correct medium, while 39 percent of the students who used the flowchart chose only the correct medium.

Braby's negative findings can also be questioned in terms of effectiveness of the media selection aids he evaluated. The ratings indicated that some of the aids resulted in less effective media choices than those made by intuition. Such findings cause one to question the formats and criteria employed by the evaluated aids. Braby does not comment on the appropriateness of the formats or criteria used by the media selection aids he evaluated. Furthermore, his descriptions of those aids are not detailed enough for the reader to determine whether or not the nature and content of the aids are appropriate.

Questions remain, then, as to what characteristics of media selection aids might be expected to lead to effective media choices and whether the design of existing aids takes advantage of these characteristics. These issues will be discussed in detail in the Analysis of Training Decision Aids section.

Military Requirements

Even if effective training decision aids for establishing training situations/levels and selecting media can be developed, they might not appear useful to military users for a number of reasons. First, aids designed for civilian users may not be appropriate for military personnel. Some criteria that might have to be considered for diverse civilian populations (e.g., blindness) would not apply to military trainees.

Second, to be useful to the military, the training decision aids must be appropriate in terms of the user's background and capabilities. Some aids may not be useful to military users because of unfamiliar terminology. Also, aids that are not prescriptive but merely list factors to be considered may not provide sufficient guidance for military users who are relatively unfamiliar with training issues.

Third, some training decision aids may be inappropriate for certain military users due to the complexity of their requirements. Military users often have to make decisions relevant to a wide variety of course work in a short period of time. No matter how effective an aid might be, users probably will not adopt it if its procedures are excessively complex and not "user friendly," or if it requires information not readily available.

Finally, a training decision aid that would be useful to one military user may not be useful to another. Military users make training decisions under a variety of conditions. In media selection, for example, a course instructor may have to select media from a limited choice of options based on what is currently available. A training designer who must decide whether to use a simulator for training personnel to operate a new weapons system has quite a different problem.

Nontraining Benefits

The use of training decision aids may provide benefits in addition to more effective training decisions. For example, the use of systematic decision procedures, established in training decision aids, might facilitate the tracking and justification of training decisions. Such procedures would be particularly useful when training decisions have to be defended or justified to higher authorities such as congressional review boards.

Summary

There is a strong possibility that properly designed training decision aids could improve the effectiveness of military decision makers in determining training situations/levels and selecting training media and aid them in tracking and justifying training decisions. To be optimally effective, however, such aids must be appropriately designed and oriented to the needs of specific users. The elements of appropriate design will be discussed in detail in the following section.

Analysis of Training Decision Aids

This section reviews the characteristics and structure of decision aids that have been developed to assist personnel in establishing training situations/levels and/or selecting media. The requirements of training decision aids are discussed and the relative effectiveness of approaches utilized in developing such aids are considered.

Of the 23 training decision aids reviewed, 20 are designed to aid in selecting training media; 2, in establishing training situations/levels; and 1, in both processes. All of these training decision aids were developed or revised between 1965 and 1987. Nine of them were developed by or for military users.

The specific decision aids reviewed in this report are listed and described in Appendix A. These aids are also identified and listed in the reference section.

Characteristics

Previous reviews of training decision aid characteristics have generally centered on media selection and excluded training situations/levels. Each review considered a different list of characteristics. Braby (1973) considered Learning Task Categories, Task Difficulty, Task Frequency, Stage of Learning, Learning Guidelines/Strategy, Stimulus Characteristics, Student Response Modes, Student Feedback Characteristics, Individualization Capability, Economic Analysis, Sensitivity to Changing Requirements, Time to Achieve Criterion, Threshold for Media Requirement, and Multiple Practice Factors. Reiser and Gagne (1982) considered the following media selection model characteristics. Display Form and Mode of Decision Making; Categories of Media; Physical Attributes (visuals, printed words, sound, motion, color, and real and simulated objects); Learner, Setting, and Task Characteristics; and Practical Factors (such as production costs and hardware availability).

The present review considers a somewhat more extensive list of characteristics than was previously examined, based on the large variety of training decision aids that are now available. Also, on occasion, consideration is given to important characteristics and interactions among characteristics that are not directly discussed in any of the reviewed decision aids.

Training decision aids can be characterized on several dimensions including the type of application intended for the aid, the format of the decision aid, the level of user guidance provided, the training unit at which the aid is directed (task, objective, etc.), and the criteria used in making decisions. The following discussion considers each of these dimensions separately.

Applications

There are a variety of applications for military training decision aids. Specific types of applications for military aids reviewed in this report are listed below.

Assisting Military Personnel to Establish Training Situations/Levels. An aid for establishing initial training situations/levels was developed by Pieper, Guard, Michael, and Kordek (1978); an aid for comparing the cost effectiveness of different training sites was developed by Collins, Hernandez, Ruck, Vaughn, Mitchell, and Rueter (1987); and an aid for determining refresher training intervals was developed by the Army (User's Manual for Predicting Task Retention, 1985).

Assisting Military Personnel to Select Media. Aids for assisting instructors to select media were developed by the Marine Corps (The Marine Corps Systems Approach to Training User's Guide (Draft), 1987) and the (Methods/Media Selection Guidelines, 1977). An aid for assisting course designers or planners to select media was developed by Braby (1973). An aid for assisting the replacement of conventional instruction with new technologies was developed by the Air Force (Nonpersonnel Studies and Analysis Services for Assessment of New Training Technologies, 1985).

Few of the aids reviewed in this report are adequately designed for military users. Some address criteria that are inappropriate for the military. Many use terminology that military users would probably not understand. Most are either too complex for personnel

who are not experts in training design or lack sufficient guidance. Even aids specifically designed for military applications are seldom designed for specific military users. This can be a problem in several ways. Users may have different levels of choices available to them. One user may have to choose from a small range of available media while another may be able to select from the broadest range of possibilities. Also, different information concerning costs, facilities, and student populations may be available to different military users. To be effective, military training decision aids should be tailored to the resources that are available to the intended user.

Formats

Reiser and Gagne (1982), in their review of media selection models, identified three basic types of display formats used for guiding the user: flowcharts, matrices, and work sheets. According to the authors, a flowchart generally provides a progressive narrowing of media choices while a matrix or worksheet typically defers choices until all selection criteria are considered. In the present survey, it was found that some decision aids combine display formats or use them with written outlines or instructions.

Although Reiser and Gagne did not discuss the relative merits of these different formats, each has its own advantage. The flowchart format is useful for reducing the number of choices to consider. The matrix format is useful for comparing a number of possibilities with respect to a single criterion (e.g., costs). The worksheet is typically used in a manner similar to the matrix but with the user providing the variables and/or rating the variables on selected criteria. The flowchart and matrix formats appear to provide users with a maximum amount of guidance. It might be an advantage to combine flowchart and matrix formats. First, flowcharts could be used to reduce the number of choices to a manageable number; then, matrix formats could be used to compare remaining choices.

None of the reviewed training decision aids combine flowcharts and matrices. However, examples of flowchart formats are provided by Anderson (1983), Bretz (1971), Levie (1975), Reiser and Gagne (1982), and Romiszowski (1974). Examples of matrix formats are provided by Braby et al. (1975), Holden (1974), the Navy (Method/Media Selection Guidelines, 1977), and Walker (1965).

Several of the reviewed decision aids are designed for use with computers. Computers appear to be particularly helpful for speeding calculations and manipulating complex data. Menu-driven computers could probably be used in conjunction with flowcharts, matrixes, or worksheets to increase their efficiency.

A computerized automated aid for determining the cost effectiveness of alternative training sites was developed by Collins et al. (1987). A computerized aid that is based on the automation of procedures for determining refresher training was developed by the Army (The User's Manual for Predicting Task Retention, 1985).

One of the reviewed media selection aids was designed for use with a computer (Kribs, Simpson, & Mark, 1983). However, as indicated later in this report, this media selection aid provides minimal user direction.

Guidance

Each of the types of formats used for training decision aids can provide different levels of guidance. A flowchart can simply identify a decision point or it may prescribe a choice based on task characteristics. A matrix format may rate media on specified

criteria that the user is to consider or it may require the user to provide the ratings. Some worksheets provide the user with lists of media to rate on different criteria. Others require the user to determine the media and/or criteria that will be rated.

Training decision aids that require users to rate potential situations/levels or media also provide different levels of guidance for the rating procedure. Some decision aids simply require the user to place a check mark beside each criterion that a particular medium satisfies and to total the number of checks. Other aids require the user to rate how well each medium satisfies each criterion. The user must average these ratings to obtain an overall score for each medium. Such ratings provide a more sensitive comparison than check marks. Still other aids require the user to assign a weighting to each criterion according to its importance. In this case, the overall score is an average of the ratings multiplied by the weightings for each medium. Weighted ratings appear to provide the most effective basis for decisions since some criteria may be much more important to the user than are others.

Decision aids that are to be used by military personnel who may not be highly experienced in instructional systems development should provide strong user guidance. Examples of aids with strong user guidance for establishing training situations/levels are provided by Pieper et al. (1978) for initial selection of training sites, Collins et al. (1987) for cost comparisons of training sites, and the Army (User's Manual for Predicting Task Retention, 1985) for determining refresher training periods. Examples of media selection aids with strong user guidance are provided by Reiser and Gagne (1982) in a flowchart format and Wagner (1965) in a matrix format. Braby et al. (1975) provides strong user guidance for cost analysis and the Air Force (Nonpersonnel Studies and Analysis Services for Assessment of New Training Technologies, 1985) for comparing cost effectiveness ratings.

Some of the guidance provided by media selection aids appears to obstruct rather than aid the decision process. This includes the identification or discussion of criteria that are not linked to the decision process and inconsistent recommendations for similar training conditions. Such guidance can only confuse the user.

Training Units/Task Types

As defined in this report, the training unit is the portion of the overall instruction to which a particular medium or set of media is applied. The training decision aids reviewed in the present report differ considerably in how they characterize a unit of training. Some (e.g., Kribs et al., 1983) specify a task as a unit to be trained. Others (e.g., Merrill & Goodman, 1972) require each task to be analyzed into lists of training objectives. Collins et al. (1987) require consideration of combinations of related tasks. For many, the unit of training is unclear.

Those aids that do not base the determination of training situations/levels and media on learning behaviors generally base such decisions on the overall characteristics of the task. A variation of this approach that might prove useful is to categorize tasks into functional areas or tasks types (e.g., electronics maintenance). Then, separate decision aids for each type of task, each with its own criteria, could be constructed. Training decision aids based on specific task types would have a more limited set of training situation/level and media possibilities than would aids designed to cover all types of tasks. Therefore, this approach should reduce the number of possibilities that must be considered in choosing training situations/levels or media. Such reductions should, in turn, make the decision process more efficient.

None of the reviewed aids use functional areas or task types as the unit of training. However, Braby et al. (1975) provide specialized media selection models for different types of learning. Conceivably, similar types of specialized media selection models could be constructed for different functional areas or task types.

Training Situation/Level Criteria

The training situation/level needs to be considered both in its own right and as one of the variables that will influence the selection of a training method and media. As used in this report, training situation/level specifies who is to receive the training, where the training is to take place, and when the training is to occur.

Who receives the training is typically specified in terms of occupation, grade level, and, for maintenance courses, the commands responsible for the task. Where the training is to take place may be specified in terms of formal school or on-the-job training (OJT). When the training is to take place may be specified in terms of preliminary, advanced, or refresher training.

In comparison to the rich body of literature on the selection of training media and the great variety of media selection decision aids that have been developed, little has been written concerning the determination of training situations/levels. An Army decision aid developed by Pieper et al. (1978) considers factors related to the training situation/level along with media considerations. The Air Force Human Resources Laboratory has developed the Training Decisions System (TDS) (Collins et al., 1987), a computerized system for aiding decisions concerning where personnel should receive training. The Army has also developed the User's Manual for Predicting Military Task Retention (1985), which provides a basis for determining when refresher training is needed. The following factors and criteria have been considered in determining the training situation/level.

Who is to be Trained. All of the training situation/level selection aids can be oriented to specific military occupations, grade levels, or command assignments.

When Training Takes Place. Pieper et al. (1978) provide criteria for establishing when initial training is to take place. One of these criteria is when the task will be performed, which, in turn, will depend on grade level and job responsibilities. Pieper et al. also indicate that tasks should not be trained until trainees have completed all prerequisite tasks.

The Army's User's Manual for Predicting Military Task Retention provides procedures that appear to be useful for determining refresher training periods. Retention scores are developed for each task based on user evaluations of task characteristics. Tables in the manual enable the user to determine, for a given retention score, how soon refresher training will be required in order to maintain a specified percentage of personnel who are proficient in the task. An Army representative has indicated that a computerized version of these procedures is also available.

Where Training Takes Place. In determining where training is to take place, Pieper et al. (1978) consider three options: initial training through resident courses (formal schooling), OJT, or no training. The Air Force's TDS considers similar options as well as field training detachments, career development courses, major command programs, mobile training teams, contractor training, and interservice programs and courses (Collins et al., 1987). All of these training options appear relevant.

Task Priorities and Training Time. In determining where the task should be trained, Pieper et al. were primarily concerned with the overall amount of time available for

formal school training and OJT, the amount of training time required for each individual task, and the priority of the task. They assign the highest priority tasks to formal school training until the overall training time limit is exceeded. The next highest priority tasks are assigned to OJT until that overall time limit is exceeded. The remainder of the tasks are not designated for training.

Training priorities cited by Pieper et al. (1978) are based on a complex rating system that includes variables such as pay grade, time to application, training time, percent of members who perform the task, and percent of time spent performing the task. Task priority and training time, as defined by Pieper et al., appear to be appropriate criteria for an initial determination of where training is to take place.

Task Appropriateness. None of the decision aids reviewed consider the role of task appropriateness in determining training situations/levels for specific tasks. Task appropriateness is independent of task priority ratings as discussed by Pieper et al. A task can have a high priority but not be appropriate for formal school training because of the manner in which it is performed. For example, tasks that are to be practiced collectively and involve large numbers of personnel (such as troop maneuvers) are ill suited for practice in a formal school. Task appropriateness should be included as a criterion in determining where training should take place.

Training Costs. Training costs appear to be a relevant criterion in the establishment of training situation levels. However, TDS (Collins et al., 1987) is the only aid that deals directly with costs in the establishment of training situations/levels. (Pieper et al. discuss costs for training settings, but do not provide a clear basis for selecting training situation levels based on costs.) TDS is designed to deal with Task Training Modules (groups of related tasks) rather than individual tasks. The TDS computer program allows the user to formulate and plot alternative paths for satisfying the training requirements of each Task Training Module and vary the number of pieces of equipment provided in the training setting. It then computes resulting training cost (based on previous cost data inputs). This allows the user to identify characteristics of the training situation that will result in the lowest training costs.

In terms of its utilization, the TDS appears more appropriate for determining costs associated with selected training situations/levels than for guiding users in the initial establishment of training situation/levels. Therefore, it should be used as an adjunct to a training situation/level selection aid. TDS should prove particularly helpful in comparing the cost effectiveness of potential training situations and in justifying selections of training situations and levels.

Different Locations. An important consideration that few decisions aids have dealt with is whether a task is to be learned, practiced, and evaluated at one or several locations. For some tasks, it may be desirable to introduce the task and teach the enabling objectives (basic skills and knowledge) in a formal school setting, but to train the terminal objective (involving practice of the actual task performance) and evaluate performance in an OJT field setting. If a school is assigned complete responsibility for a task, but only addresses the enabling objectives, the terminal behavior may not be properly trained and evaluated. Therefore, in assigning task responsibilities to formal schools or OJT, it is desirable to provide settings for both terminal and enabling objectives.

Incorporation of Existing Situation/Level Decision Aids. None of the three aids discussed above provide a completely satisfactory basis for establishing training situations/levels. Pieper et al. (1978) gave inadequate consideration to costs, task appropriateness, and possibilities for combining formal school training and OJT. Their

procedures are complex and difficult to follow. The Air Force's TDS (Collins et al., 1987) and the Army's User's Manual for Predicting Military Task Retention (1985) only address a few of the issues involved in determining training situations/levels. However, TDS provides efficient automated procedures for making cost effectiveness comparisons among different training situations/levels and the Army's manual provides easy to follow procedures for determining refresher training intervals. The procedures used in these aids could be effectively incorporated into a more comprehensive aid that addresses all of the issues involved in determining training situations/levels.

Training Presentation Method/Media Criteria

Methods versus Media. Media selection aids vary greatly in the selection criteria that they employ. One of the major issues in establishing criteria for media selection is whether to establish separate criteria for training presentation methods and training media. A few of the media selection aids reviewed in this report distinguish between method and media (The Marine Corps Systems Approach to Training User's Guide (Draft), 1987; Methods/Media Selection Guidelines, 1977; and Pieper, et al., 1978). Similar kinds of distinctions were made by Tosti and Ball (1969) between medium and "presentation form" and by Levie (1975) between media and media attributes. How can training methods be distinguished from media? The Methods/Media Selection Guidelines define a method as a procedure or process for attaining an objective and a medium as a channel of communication that provides the hardware and software for conveying information. This distinction between methods and media is maintained in the present discussion of media selection criteria.

The importance of distinguishing between methods and media has been supported by Clark (1983). Following a review of research studies that compared the benefits of different types of media delivery systems, Clark concluded that "Consistent evidence is found for the generalization that there are no learning benefits to be gained from employing any specific medium to deliver instruction" (p. 445). Clark contends that beneficial effects ascribed to media can, in actuality, be attributed to the learning methods used in presenting the instruction. Clark admits that certain combinations of training methods and media appear to be more effective than others. He points out, for example, that training approaches such as the personalized system of instruction (Keller, 1968) and programmed instruction have proven to be more effective than conventional forms of instruction. However, he argues that, in both cases, the presentation methods (addition of structure, shorter steps, reduced verbal loads, and self-pacing) rather than the media make the difference.

Orlansky and String (1981) support Clark's contention. They reviewed a series of military studies which examine the effects of replacing conventional, group-paced instruction with computer-based instruction (CBI), computer-managed instruction (CMI), or individualized (self-paced) instruction without computers. They point out that the magnitude of reductions in training time achieved with CBI or CMI is no greater than that achieved with individualized instruction. These results suggest that the method of self-pacing could account for the efficiency effects achieved with computer media.

Petkovich and Tennyson (1984), in a critical analysis of Clark's study, conclude that methods may dictate, to some extent, the type of media employed. They argue, for example, that the complex mathematical models used by some computer training systems would be difficult or impossible for a teacher to employ during the course of instruction. It is not difficult to visualize other examples. A conventional movie film would be a poor choice of medium for programmed instruction since it is difficult to provide branching based on student responses. The suitability of media for methods is a particularly

important consideration for military training involving weapon systems and simulations of combat conditions. For example, training with a laser rifle allows for a type of realistic, interactive practice that simply would not be possible with an actual weapon.

These examples are not in conflict with Clark's contention that the method rather than the medium is the primary factor in determining instructional effectiveness. They merely illustrate that the selection of a method may greatly limit the range of possible media choices.

Even where different media produce equally effective training, there still may be compelling reasons to select one medium over another. Costs are an obvious reason. Some media are certainly more expensive to develop and use than are others. Ease of updating might be another significant factor. Some media presentations are difficult to change and update while others can be easily modified. Mobility is still another factor to consider. Some media are relatively easy to move from one location to another while others are difficult to transport. Mobility is an important consideration for training organizations such as military mobile training teams that must move from one work site to another in order to provide training.

The majority of media selection aids do not distinguish between training methods and media. Some appear to equate the two. For example, the Air Force's Nonpersonnel Studies and Analysis Services (1985), Courseware's Media Selection (1974), and Reiser and Gagne's model (1982) refer to a simulation as a type of medium. A simulation, however, can be viewed as a method that is distinct from any media that are used in its presentation. There are paper and pencil simulations, computer simulations, mockup simulations, etc.

Since different criteria may apply in selecting training methods and media and since selection processes for methods and media are often confounded, selection criteria for the two should be considered independently. This is done in the following discussion.

Types of Methods. Those reviewed media selection aids that separate methods from media vary considerably in the types of characteristics they consider. The Methods/Media Selection Guidelines (1977) identify 8 methods: Lecture, Demonstration, Discussion, Performance, Independent Study, Programmed Instruction, Peer Training, and Simulation. Pieper et al. (1978) list 15 methods: Case Study, Computer Assisted Instruction, Demonstration, Games, Group Interview, Guided Discussion, In-basket Exercise, Peer Tutor, Programmed Instruction, Programmed Practical Exercise, Role Playing, Study Assignment Book, Traditional Classroom, Traditional Practical Exercises, and Tutoring. While Tosti and Ball (1969) and Levie (1975) do not identify training methods directly, the factors they do identify are suggestive of training methods. Tosti and Ball list 3 types of presentation formats: Stimulus Factors (use of words, pictures, symbols, motion, etc.), Response Factors (including the type and frequency of learner responses), and Management Factors (involving actions to modify the instruction). Levie lists 5 types of media attributes: Sign Vehicle Characteristics (e.g., words vs. pictures), Realism Cues (e.g., color vs. black and white and motion vs. still), Sensory Modalities (e.g., seeing vs. hearing vs. seeing and hearing), Locus of Control Characteristics (e.g., fixed vs. flexible pace), and Response/Feedback Characteristics (e.g., overt vs. covert responding).

A summary of the various training method characteristics listed or implied above, or recommended in other media selection aids or in this report is presented in Table 1. These characteristics are categorized to clarify the types of methodological decisions to be made. Listed method characteristics vary along a variety of dimensions, each of which

Table 1

Categories of Training Method Characteristics

Dimension	Class	Type
Control of presentation	Uncontrolled	Nonprogrammed independent study
	Live control	Instructor presentation, or peer presentation
	Device control	Programmed instruction (computer or text)
Control of response	Uncontrolled	No response, nonmonitored response
	Live control	Instructor controlled, peer controlled
	Device control	Programmed instruction (automated or manual)
Dispersion of training	Dispersed	Individuals, groups
	Face-to-face	Individuals, groups
Fidelity of training conditions	Nonequipment tasks	Real performance, simulated performance
	Tasks trained on real equipment	Real performance, simulated performance
	Tasks trained on simulated equipment	Real performance, simulated performance
Focus of presentation	Large group	Team training, independent training
	Small group	Team training, independent training
	Individual	Independent training
Motivation enhancement	Gaming	Role playing, computer or board games, etc.
	Rewards	Intrinsic /extrinsic
	Competition	Between individuals, between groups
Passive/active student role	Passive	Lecture or demonstration
	Active	Role playing, discussions, etc.
Provision of feedback	None	No quiz or test, quiz or test without results
	Provided	Live or by a device
Retention enhanement	Memory develoment	Repetition, mnemonics
	Memory aid	Job performance aid
Stimulus characteristics	Audio	Speech or other sounds, no sounds
	Color	Color, black and white
	Motion	Full, partial, none
	Kinetic	Balance, position, etc.
	Smell	Odors
	Taste	Tastes
	Touch	Textures
	Visuals	Print, pictorial, graphic

may characterize several classes or types of media. Since a single training method may be characterized on a number of dimensions (e.g., face-to-face training for a small group using programmed instruction with gaming and colored visuals presented without motion), the number of possible method combinations that could be identified from the characteristics is very large. The availability of such a comprehensive listing of method characteristics should encourage decision makers to consider the full range of methodological possibilities in designing training presentations.

Method Selection Outcomes. Not only are a wide variety of methods available, the outcome of training method selection may be several different methods rather than a single method. In learning to perform a given task, different methods may be appropriate for different instructional events. One method might be appropriate for introducing a task, another for providing practice, etc. In addition, many methods are not mutually exclusive but can be used together for a given instructional event. For example, in learning a task, programming may be an effective method for controlling student responses and providing feedback while, at the same time, repetition with gaming may be an effective method for helping the students memorize key steps. However, only a few of the reviewed media selection aids provide guidance for combining training methods.

Method Criteria. While only a few media selection aids specify separate criteria for selection of methods per se, some provide criteria for media selection that carry implications for method selection. These and other criteria that are relevant to method selection are discussed below.

1. Learner characteristics. Reiser and Gagne (1982) point out that some decision aids use learner characteristics such as age and reading ability as criteria in selecting media. The importance of selecting media to correspond to learner characteristics has been largely discounted by Clark (1983). Learner characteristics could be important in selecting training methods. For example, the representation of printed text is inappropriate for blind students or nonreaders whether the medium is a book, film, or computer. However, most of the learner characteristics cited in training decision aids would typically not occur in most military settings because of military entry requirements for physical and mental abilities.

2. Training situation. Other criteria that have been considered in selecting a training method relate to the training situation. One important characteristic of the training situation is location. For example, Anderson (1983) provides an option for dispersed training in settings where face-to-face training is impractical. In such situations, some independent method of study would have to be provided. Another location consideration is whether the training is to be conducted in a classroom or in the field. Obviously, many classroom training methods are inappropriate for field training conditions.

Another important characteristic of the training situation is team performance requirements. If only individual performance is involved, tasks may be practiced individually or in groups. Team performance requirements, however, may necessitate group practice.

Still another important characteristic of the training situation is group size (e.g., Pieper et al., 1978). Group size may limit the types of training methods that can be successfully employed. For example, at the Navy propulsion school at Great Lakes, students are given watchstation practice on operating propulsion equipment. However, because of training time limitations, relatively large groups of students are assigned to

each watchstation. These watchstation tasks cannot be performed realistically by groups of individuals. Therefore, in this situation, class size inhibits the effectiveness of the training.

3. Modes or types of learning. Many training decision aids have considered modes of learning (affective, cognitive, and motor) or types of learning (e.g., decision making or gross motor skills) in selecting media. Most of the reviewed aids require task objectives to be categorized by mode or task type. Several aids (e.g., Anderson, 1983; Braby et al., 1975; Reiser & Gagne, 1983) base media decisions on modes or types of learning. Few tasks, however, involve only one mode or type of learning. Most require a mix. Furthermore, labeling a task as a "cognitive task" or a "gross motor skill" does little to clarify the types of training presentation methods or media that would be appropriate. In media selection aids that use modes or types of learning in selecting media, the basis for associating a given media with a given mode or type of learning is typically unclear and unstated. In general, most training presentation methods and media can be applied to a broad range of learning modes and types. The following criteria appear to provide more obvious links to specific training presentation methods and media.

4. Events of instruction. Events of instruction are of primary importance when the nature of the instruction would be expected to change as the course progresses. For example, in training personnel to perform a task, the instructor may introduce the task, provide information about the task, allow the trainee to practice the task, and, finally, evaluate the trainee's performance.

Events of instruction have been considered in a number of media selection aids and reviews. According to Reiser and Gagne (1982), "Most media selection models indicate that events of instruction should be planned before selecting the media. ... Media are then chosen based in part on their ability to present instructional events" (p. 507).

As with several previous cited criteria, instructional events appear to have the most direct impact on the selection of training methods rather than media. For example, a programmed method of instruction may be appropriate for presenting information about the task but not for providing task practice. Once the method is established, media can be selected from those that are compatible with the established method. As Reiser and Gagne point out, some events of instruction can be presented equally well by any media while others are impossible for some media to present.

Despite the widespread recognition of the importance of instructional events in media selection, none of the reviewed media selection aids provide specific criteria for selecting training methods based on instructional events. This is unfortunate since different training methods appear appropriate for different instructional events and some criteria for selecting training methods only apply to certain instructional events. In the remainder of this section, each of the selection criteria will be considered with respect to the instructional events to which they apply.

5. Stimulus characteristics. Stimulus characteristics (e.g., color, motion, audio, etc.) must be considered for all instructional events. The selected training method must incorporate all of the stimulus characteristics required to demonstrate the task or depict critical task characteristics. Media can then be selected from those that are capable of presenting the required stimulus characteristics. Although none of the reviewed aids relate stimulus features directly to selection of training, most relate stimulus characteristics to media selection (e.g., Kemp, 1980).

6. Motivational requirements. The affective mode of learning deals primarily with motivational issues. However, a motivational component may be involved in any type of learning. In building motivation, most training decision aids limit their considerations to the selection of a training method that would interest the students. Gaming techniques have been identified as a training method in some decision aids (e.g., Pieper et al., 1978). Gaming techniques increase motivation, especially during instructional events in which learning and practice require extensive repetition.

Group practice can be used to build motivation although few aids have explicitly considered such methods. Group practice may be desirable (even when team training is not required) to promote competition or enable trainees to develop confidence in themselves and in the abilities of their team members. This would be especially important for training in combat tasks.

Motivational factors apply to all stages of learning with the possible exception of evaluation. However, the focus of the motivation may vary. In the introductory stages of instruction where an overview of the course is being provided, the main motivational consideration is development of an interest in learning the task. In learning and practicing the task, gaming techniques are relevant. Group performance, as a method for enhancing motivation, is relevant, of course, only to task practice.

7. Retention requirements. Retention is one type of cognitive learning skill that is relevant for selecting a training method. If retention requirements are demanding, some method for facilitating recall (such as use of mnemonics, repetition, or job performance aids) should be used. None of the reviewed aids suggest specific methods for dealing with retention requirements.

8. Programming. For assisting a student to learn a task, a group of related training techniques may be characterized as *programming*. Definitions of programming vary greatly. However, for the purpose of this report, programmed techniques will include individualization, self-pacing, presentation of information in small frames or units, eliciting student responses, and providing feedback. Programming techniques have been found to improve training effectiveness (Orlansky & String, 1981). However, few guidelines have been provided to indicate where such procedures are appropriate.

Programming can be used to individualize instruction by directing students to different learning paths depending on their responses. For this reason, programming is often appropriate where diverse student skills and knowledge are expected.

Programming might also facilitate learning of difficult training content. This is because the effect of programming is to separate content into manageable training units and establish mastery of each unit before proceeding to the next.

While programming techniques can be used wherever independent study is needed, the need for independent study is not, of itself, a justification for programming. For example, correspondence courses may use conventional as well as programmed texts for providing independent study.

Since the development of programmed course materials is apt to be more costly than the development of conventional materials, it should probably be considered only when required by the complexity of the instruction or the diversity of student skills and knowledge.

9. Automation. Automation has typically been considered as some form of computer application. Automation of training during the learning and practice of tasks is a relevant consideration whenever instruction is programmed. Automated programmed instruction (usually referred to as computer-assisted instruction or CAI) has been used with a wide variety of course work. With CAI, the student "interacts in real time, via an interactive terminal with instructional material that is stored in the computer" (Orlansky & String, 1981, p. 47). However, as stated earlier, Orlansky and String also found that effects attributed to CAI may, in fact, result from other factors such as self-pacing of instruction.

Automation can have special training advantages that go beyond the types of CAI programming applications reviewed by Orlansky and String. For example, automation can be an important feature in developing games or simulations.

Automation in the form of computer-managed instruction (CMI) can be considered whether or not automation is used in training the task. Orlansky and String report that CMI, like CAI, does not improve the efficiency of conventional, group-paced, military training courses to a greater extent than does nonautomated individualized instruction.

However, automation with CMI offers advantages in addition to instructional efficiency. Automated data processing can facilitate maintaining performance records and relating these records to other data. It should be particularly effective in situations where large student/instructor ratios are involved and where large scale records of test performance must be maintained and compared to other criteria.

Media that involve automated methods of training are often listed as potential candidates by media selection aids. However, none of the reviewed aids provide criteria for determining whether automated training and/or data processing are required.

10. Simulation. In providing task practice and in evaluating performance, there is always a question whether the actual task is to be performed or some form of simulation is to be used. The reviewed media selection aids provide little guidance for determining when a simulation should be used and none for determining what method of simulation should be employed. There are a number of criteria to consider in determining what aspects of a task, if any, are to be simulated during training.

Having the individual perform the actual task has the advantage of direct transfer of training. Personnel are trained and evaluated in performing exactly the same behaviors they perform on the job. Task practice and performance evaluation should be conducted under actual task conditions wherever it is possible and practical to do so.

Simulation methods should typically be considered when it is not possible or practical to perform the actual task. Simulations may be required because tasks are too dangerous, time consuming, or costly to perform live; the actual task conditions cannot be established or controlled; or tasks are difficult and need to be presented in a simplified format in order to facilitate learning.

If the actual task is to be performed, training methods and media can simply reflect task performance. However, when simulations are required, the selection of methods and media becomes more complicated. Two factors that should be considered in determining an appropriate method of simulation are the purpose of the simulation and fidelity requirements.

The purpose of the simulation will dictate whether the physical or functional characteristics of the equipment must be simulated, or both. For example, if the purpose is to demonstrate how a system operates, the functional characteristics must be simulated. In terms of the operation, the actual physical characteristics of the system may be incidental. Conversely, if the purpose is to familiarize the student with the appearance of a system and the position of its parts, the physical characteristics must be simulated. In some cases, both physical and functional characteristics are important. For example, for a laser rifle simulation, it may be important to duplicate both the weight and size of the actual weapon as well as its aiming and firing functions.

In simulating functional characteristics of a task, both the functions of the equipment and those of the performer must be considered. A simulated task may involve actual behaviors with simulated equipment, simulated behaviors with actual equipment, or simulated behaviors with simulated equipment.

Having determined what task characteristics are to be simulated, the fidelity of the simulation also must be determined. In general, simulations should duplicate actual task conditions as closely as possible to maximize transfer of training. However, as Montague (1982) points out, high fidelity may not be necessary or even desirable in some training contexts. For example, low fidelity may simplify task conditions in order to facilitate learning during earlier stages of instruction.

Montague also argues that, in order to determine the fidelity requirements of a simulator, "it is necessary to describe the task precisely in terms of the way it needs to be represented mentally" (p. 9). This, in turn, requires a thorough analysis of learning requirements at different levels of task competency. "What is needed is a complete description of what individuals do at different levels of competency and, then, more adequate design of the simulation for promoting learning can be contrived" (p. 8). Montague's statement implies that selecting an appropriate level of simulation fidelity requires an extensive analysis to determine the requirements of the training situation.

In practice, media selection aids have given little attention to simulation requirements. Some simply list simulation as a choice of media. A few require the user to determine whether a simulation is required. None provide criteria for determining the type of simulation or its fidelity. However, it is the characteristics of the simulation that indicate what media characteristics would be necessary to present the simulation.

Types of Media. Media specifications vary greatly from one decision aid to another. Some of the reviewed aids do not list media candidates but require the user to determine the types of media to be considered. Of those that do list media, some only consider a few media or media categories while others consider a large variety of specific media. Table 2 presents a summary of the types of training media that have been considered in media selection aids.

Media Selection Outcomes. Since it may be desirable to use several different training methods with the same task and since different methods may require or work best with different media, a mix of media may be appropriate for any given instructional application. Some media selection decision aids have specifically provided for the selection of media mixes (Braby et al., 1971; Gagne & Briggs, 1974; Goodman, 1971; Holden, 1974; Kemp, 1980; Kribs et al., 1983; Leiblum, 1980; Merrill & Goodman, 1972; Methods/Media Selection Guidelines, 1977; Reiser & Gagne, 1982; and Romiszowski, 1974). Few, however, have provided an adequate basis for determining the type of media mix that is required.

Table 2

Types of Training Media

- Audio Recordings
  - Audiodisc playback system
  - Audiotape system
  - Dial access audio information-retrieval system (random or scheduled)
  - Radio (active and passive)
  - Record
  - Telephone (individual or conference system)
- Board Displays
  - Blackboard
  - Bulletin board
  - Diorama
  - Felt board
  - Magnetic board
  - Whiteboard
- Charts/Posters
- Computers
- Film Presentations
  - Silent film
  - Sound film
- Filmstrip Presentations
- Holographs
- Interactive Videodiscs
- Live Instructor Presentations
- Microfilm Presentations
- Models/Mockups
  - Equipment displays (2-D or 3-D, cutaway or whole, static or dynamic)
  - Terrain models (fixed models, sand tables, etc.)
- Opaque Projections
- Realia
  - Kits
  - Real equipment
  - Real objects
  - Real people
  - Specimens
- Slide Presentations
  - Random access slides
  - Slide projection system
  - Sound/slide projection system
- Teaching Machines
  - Branching
  - Linear
- Televised Presentations
  - Broadcast TV
  - Closed circuit TV
  - Videodisc
  - Videotape
- Textual Presentations
  - Handouts
  - Periodicals
  - Reference books
  - Study card sets
  - Textbooks
  - Workbooks
- Transparency Presentations

Media Criteria. The following criteria apply to the selection of media or combinations of media and methods.

1. Training method. The first major consideration in selecting media is the training method. As Petrovich and Tennyson (1984) point out, in some cases the method may dictate the medium to be used. In any case, each medium must be compatible with the training methods employed. For example, if programmed instruction has been selected as a method, then a medium that is compatible with a programmed approach (e.g., computer instruction or programmed text) should be selected. If a high fidelity functional simulation method is required, a medium that can provide those features (such as an interactive videodisc) would be required. If the method calls for displays of motion or color or presentations of sound, then media that have these capabilities should be selected.

While this study has argued that the selection of media should be based, in part, on training method decisions, the final determination of training methods may have to be made in conjunction with media selection. This is due to the fact that the same criteria that apply to training media (costs, training time, etc.) also apply to training methods. From this perspective, training method decisions made earlier must be considered as preliminary and subject to revision during the selection of training media.

As previously stated, aids that provide procedures for selecting training presentation methods separately from training media were developed by the Marine Corps (Marine Corps Systems Approach to Training User's Guide (Draft), 1987), the Navy (Methods/Media Selection Guidelines, 1977), and the Army (Pieper et al., 1978). However, none of these aids provides explicit procedures for basing media choices on the selected training methods, as is recommended in this report. Because of the complexities involved in linking media to methods, effective guidance is needed.

2. Training costs. While Clark (1983) concluded that media do not affect training effectiveness when considered apart from the training method employed, he admitted that media can impact on factors such as training costs and time. A number of media selection decision aids have considered training cost as a criterion. Some of these aids (e.g., Nonpersonnel Studies and Analysis Services, 1985 and Lonigro & Eschenbrenner, 1973) have simply rated media on a cost scale (e.g., low, medium, and high). Others (e.g., Braby et al., 1975) have developed elaborate formulas for specifying exact costs. These formulas may include implementation costs as well as initial development/acquisition costs. Costs for different media systems are often compared over periods of time.

The Air Force's Nonpersonnel Studies and Analysis Services media selection model advocates the comparison of media systems in terms of a cost-effectiveness relationship designed by Keeney and Raiffa (1976). Selecting the most cost-effective medium is a straight forward process as long as one medium is both less costly and more effective than the others. However, if one medium is less costly but another is more effective, how should the selection be made? The best rule of thumb in this situation may be to take the most effective method that is affordable.

Conducting a detailed cost analysis is a time consuming process that requires considerable information concerning training facilities and student throughput that may not be readily available to decision makers. Such cost analysis may only be appropriate in situations where tradeoffs between high cost training media (e.g., actual equipment vs. simulators) are being considered, and the decision makers have the necessary time and information to conduct an extended cost evaluation. A media selection aid should specify

the conditions that would necessitate a detailed cost analysis. None of the reviewed aids did that.

Training time is typically considered to impact on training costs. However, it can be an important consideration in its own right and should be used as a criterion wherever efficiency of training is important.

3. Revision, mobility, and development time. Additional criteria that appear to be appropriate for media selection are ease of revision, level of mobility, and development time. If the course content is likely to require frequent modification and updating, then it would be desirable to choose media that allow changes to be made easily. If the course work is to be moved from place to place, the chosen media should be mobile. Finally, if course development time is limited, media that are readily acquired and allow for quick development of course work should be chosen.

Media requirements such as ease of revision, mobility of training devices, and development time are mentioned in several media selection aids. However, users need guidance to determine which media systems best satisfy these requirements. None of the reviewed aids provides such guidance.

4. Availability and personal preference. Media selection may be looked at as a process of elimination. The establishment of method, cost, revision, mobility, and development time considerations should greatly reduce the number of potential media that could be used. For many training conditions, however, a number of reasonable possibilities may still exist at this point of the analysis. Final decisions may best be made by the individual who is to provide the instruction. Some media selection decision aids have suggested criteria that would be appropriate at this level of decision making (e.g., The Marine Corps Systems Approach to Training User's Guide (Draft), 1987).

One criterion for the instructor would be availability. If several media are possible choices, the instructor may as well work with a medium that is already available rather than one that must be acquired. This is especially true if instructional packages have already been developed and are available for the instructor to use. For example, if the instructor has a choice between introducing a task with a live lecture or a film that has already been prepared, the use of the film would save lecture preparation time.

Another criterion for the instructor that may be considered at this final level of decision making is familiarity with the media choices. When other factors have been equated, it may be best to allow instructors to use media with which they can work comfortably.

CONCLUSIONS

1. Most existing training decision aids have not been found to be effective in aiding personnel to select training situations/levels or media.

2. Desirable attributes for military training decision aids can be identified and justified from reviews of current research and examinations of existing aids.

3. Existing decision aids for determining relative costs of training paths and refresher training requirements appear to be effective adjuncts to aid in the process of establishing training situations/levels.

4. None of the reviewed aids satisfy all of the required attributes identified in this report. However, many existing training decision aids contain desirable criteria that could be incorporated into more effective aids that would be suitable for military requirements.

5. Methods for designing more effective military training decision aids that incorporate desirable selection criteria are needed.

RECOMMENDATIONS

The following recommendations provide a basis for guiding the design and development of effective military training decision aids intended for use in establishing training situations/levels and selecting media. Military training decision aids, based on these recommendations, should improve the quality of training decisions and result in more cost-effective training programs. Each recommendation references the specific discussion (in this report) on which it is based.

1. Develop training decision aids for specific military applications (see pp. 5 & 6).

Training decision aids used by the military should be designed for the specific applications that they are to be used. They should be compatible with user abilities and resources and the student populations for which they are designed.

2. Combine computerized flowchart and matrix formats in structuring decision aids (see p. 6).

A flowchart with decision points should be used initially to reduce the choices to a manageable number. Comparisons of remaining choices should be guided by a matrix type format. A menu-driven computer system should be used to guide the user through these decision processes.

3. Provide detailed guidance for decision makers (see pp. 6 & 7).

Military users may have little experience in establishing training situations/levels and selecting media. Therefore, they should receive detailed guidance in terms of the types of training methods and media that should be considered and the characteristics of the training situation that would lead to the selection of specific methods and media.

4. Develop decision aids for specific types of tasks (see pp. 7 & 8).

Existing training decision aids are designed to deal with a wide range of tasks or training objectives. In contrast to these approaches, it is recommended that training aids be developed for specific types of tasks. This approach will enable users to deal with similar tasks in the same manner and also reduce the number of decisions needed to select training situations/levels or media for a given type of task.

5. Select training situations/levels based on task prerequisites, training priorities, available training time, task appropriateness, and training costs (see pp. 8-10).

Training situation/level specifications include who is responsible for performing the task, when the task requires training, and where the training should take place. If

portions of the task are to be taught at different locations, specifications should also indicate when and where each portion is to be taught. Criteria that should be used in specifying training situations/levels are training priorities, available training time, task appropriateness, and training costs.

6. Use existing situation/level decision aids for determining relative costs and refresher training intervals (see pp. 9-10).

The decision process for selecting training situations/levels should include a system similar to the Air Force's computerized Training Decisions System for determining comparative costs of different training locations. It should also include a system similar to the Army's User Manual for Predicting Military Task Retention for determining when refresher training should occur.

7. Select training presentation methods based on training location, group characteristics, training events, stimulus characteristics, affective (motivational) requirements, level of difficulty, programming requirements, group practice, simulation requirements, and requirements for automation of testing and data management (see pp.13-17).

Training presentation methods should be established independently prior to the selection of training media. Training location and group characteristics should be used first to reduce the number of possible choices. Then, specific training presentation methods should be determined for each event of instruction. In introducing a task and in all other instructional events, stimulus characteristics (requirements for color, sound motion, etc. that are needed to effectively depict the task), and affective (motivational) requirements are relevant. Stimulus characteristics should be based on the sensory characteristics required for the performance of the task, and the development of student interest. Motivational considerations should be based on the need to create interest or to promote high levels of performance.

In initial learning, level of difficulty and programming requirements should also be considered. If coursework is difficult due to retention requirements, some method for facilitating recall (such as mnemonics, repetition, or job performance aids) should be used. If extensive repetition is required or motivation is a problem, gaming techniques should be considered.

If coursework is difficult due to the complexity of the material, programming should be considered. Programmed instruction provides control over student progress, elicits student responses, and provides feedback. Programmed instruction may be more costly to develop than conventional instruction but it has frequently been found to improve learning effectiveness.

Automated instruction using computer presentations may be considered for use in conjunction with programmed instruction or gaming techniques.

In practicing the task, group practice requirements and simulation requirements should also be considered. Group practice may be required to train personnel to perform as a team. However, even when team skills can be obtained through individual instruction, group practice may still be appropriate for providing competition or building confidence in team members.

Simulations should be considered whenever tasks are too dangerous, time consuming, costly, or difficult to train under actual task conditions. If equipment is

involved, it should be determined if the functional or physical characteristics of the equipment need to be simulated or both. Class size should also be taken into account in developing simulations. Details of the simulation method cannot be specified until an extensive analysis of the learning requirements of the students has been conducted.

In testing or evaluating performance, requirements for automation of testing and data management procedures should be considered. Automation of testing should be considered for situations where large populations of students are involved and/or test performance data must be retained and compared against other criteria.

8. Select training media based on training presentation methods; requirements for modification, mobility, and development time; costs; availability; and instructor preference (see p. 19-20)

First, media choices that are incompatible with selected training presentation methods should be eliminated. Then, other media choices should be further reduced based on practical considerations. If the coursework is expected to undergo considerable change over time, then media with presentations that are difficult to modify should be eliminated. If a high degree of training mobility is required, media that are not easily transported should be eliminated. If a short development time is required, media that require extensive time to develop should probably not be considered. If none of the prospective media can satisfy all three requirements, then the relative importance of these requirements should be determined and the media that satisfy the most high priority requirements should be selected.

When more than one acceptable candidate media have been identified, cost-effectiveness considerations should be applied. A good rule of thumb is to determine the relative effectiveness of media combinations and then select the most effective media combination that can be afforded. Effectiveness can be judged in terms of how well the media present the method and satisfy requirements for modification, mobility, and available development time. Effectiveness judgments should be based on weighted ratings of significant characteristics.

Initial cost judgments should be made with the assistance of a media/cost matrix that indicates relative levels of media cost (high to low). For medium or low cost media, detailed cost analyses are probably not cost-effective. However, where two or more high cost media are being considered, elaborate cost comparisons may be justified. In making specific cost comparisons, it is important to take into account whether existing media presentations are already available. Costs of previously acquired media systems should be listed as zero unless additional costs are involved for maintenance.

Where two or more candidate media appear equally effective and affordable, it is probably best to leave it to the individual instructors to decide which they prefer to use based on the availability of the media and/or on their own expertise and familiarity with the media.

9. Consider a combination of training presentation methods and media for teaching each task.

A variety of training presentation methods should be considered for each task to be trained (see pp. 11-13). Method selection outcomes should often be mixes of methods rather than a single instructional approach (e.g., programmed instruction and repetition might be used together effectively in aiding the student to learn the task) (see p. 13).

Different training presentation methods should be considered for different instructional events (introduction, learning, practice, and evaluation) (see p. 14). Also, since it may be desirable to use several different training methods for the same task, and since different methods may require or work best with different media, a combination of media should be considered for any given instructional application (see p. 17).

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[a]Training decision aid described and discussed in Appendix A.

GLOSSARY

Special terms used in this report are defined in relation to the context of this report. They may be used differently in other reports or contexts.

Affective. A mode of learning related to motivation or attitude. An affective mode of learning might promote positive job attitudes, encourage team spirit, etc.

Cognitive. A mode of learning related to thinking skills. A cognitive mode of learning might promote such skills as remembering, decision making, etc.

Computer-assisted Instruction (CAI). A training system where a computer provides instruction as well as other training functions.

Computer-managed Instruction (CMI). A training system where a computer provides training functions such as feedback, testing, and data management but not instruction.

Content Stimulus Characteristics. Physical characteristics of the task that are part of the training content such as color, sound, motion, etc.

Dispersed Training. A training method that provides instruction to trainees at separate locations rather than to a group of trainees at the same location. Correspondence coursework and closed circuit television are two methods commonly used to provide dispersed training.

Feedback. Information provided to trainees concerning the adequacy of their responses during training or evaluation.

Flowchart Format. A training decision aid format that graphically displays sequences of steps and often provides decision points with alternative branches.

Functional Area. A related group of tasks with generic characteristics suitable for a particular set of training situations/levels and/or training media. The terms "functional area" and "task type" are used interchangeably in this report.

Gaming. A training presentation method that presents instruction in the form of a game to motivate trainees. The gaming technique may simulate the actual behaviors to be trained (as in war games) or provide context that is independent of the training content (for example, by associating response times for mathematical solutions with the speed of a graphic depiction of a running horse).

Individualized Training or Instruction. A training presentation method that enables individuals to proceed at their own pace, in contrast to conventional group-paced training where a class of individuals receives the same training inputs and proceeds at the same pace. Individuals may receive different training based on their diagnosed requirements.

Instructional Events. Events that occur during the presentation of training programs. For the present report, instructional events include introduction of the task content, presentation of information relevant to the task, task practice, and evaluation of performance.

Matrix Format. A training decision aid format that graphically relates two or more types of information (e.g., types of training media and types of training methods) to provide an overall depiction of relationships (e.g., which media are appropriate for which methods).

Mode of Learning. A general type of learning that may occur during training. The three modes of learning referred to in this report are affective, cognitive, and psychomotor.

Psychomotor. A mode of learning that involves physical skills. A psychomotor mode of learning might promote skills involving body movement, manual dexterity, etc.

Self-paced. A training presentation method that enables learners to proceed through instruction at their own pace.

Simulation. A training presentation method in which the physical and/or functional aspects of a task are simplified or modified to allow practice or facilitate learning. A mockup is a type of simulation.

Simulation Fidelity. The degree to which a simulation replicates the actual physical and/or functional aspects of a task.

Stage of Training. The point at which training is provided in the development of the individual's task competency. In the present report, stages of training include preliminary, advanced, and refresher training.

Stimulus Characteristics. Features of the task that involve sensory inputs (color, sound, motion, etc.).

Task Type. A related group of tasks with generic characteristics suitable for a particular set of training situations/levels and/or training media. The terms "task type" and "functional area" are used interchangeably in this report.

Training Medium (Media). The channel of communication that provides the hardware and software for conveying information as distinguished from the "method" or "method of presentation," which is a procedure or process for obtaining a training objective. An example of a medium would be a computer.

Training Presentation Method. The procedure or process for obtaining a training objective as distinguished from a "medium," which refers to the channel of communication that provides the hardware and software for conveying information. An example of a method of presentation would be programmed instruction.

Training Situation/Level. The specification of where training is to be provided (in formal schools or at unit commands), when it is to be provided (during preliminary, advanced, or refresher training), and who should receive the training (what MOSs, grade levels, and, where appropriate, command responsibilities).

Training Unit. The portion of the overall instruction to which a particular medium or set of media is addressed.

Type of Learning. The type of outcome to be achieved for a given task within a given mode of learning. For example, one type of learning that might be required for a task within the cognitive mode is concept formation. One type of learning that might be required for a task within the psychophysical mode is manual dexterity.

APPENDIX A

DESCRIPTIONS OF TRAINING DECISION AIDS

CONTENTS

DESCRIPTIONS OF TRAINING DECISION AIDS

This appendix contains a description of each of the training decision aids discussed or referenced in this report. Aids for establishing training situations/levels and for selecting training media are included. Each training decision aid is identified by its author or the title of the book, article, or publication in which the aid is described.

The following information, as appropriate, is provided for each training decision aid:

1. The intended users of the aid.
2. The student population that the aid was designed to support.
3. The media and/or situation/level covered by the aid.
4. The format for providing user direction (flowchart, matrix, etc.).
5. The procedures followed and the criteria used in applying the aid.
6. The outcome of the selection process.

The effectiveness of the various procedures and the appropriateness of the criteria employed by the aids are discussed in the body of this report. However, in specific instances where additional guidance may be needed, no further guidance is provided.

Anderson (1983)

Intended Users

This media selection decision aid is designed for use by course writers and instructors.

Student Population

The target population for the instruction appears to be any student audience.

Media Covered

This aid covers 10 classes of media: audio, printed material, audio-print, projected still-visual, audio-projected still-visual, motion-visual, audio-motion visual, physical objects, human and situational resources, and computers. Each class consists of from one to four media for a total of 37 specific media. Specific media vary from audio tapes, manuals, and job-aids to computers.

Format for Providing User Direction

User direction is provided by a combination of flowcharts, check lists, and text.

Procedures and Criteria

The aid directs users to:

1. Decide whether their purpose is to provide "instruction" or "information." (In the present military training context, we are only interested in providing instruction.) The users determine whether it is appropriate to use an instructor supported by an instructional aid or an instructional medium (a stand-alone presentation that does not require an instructor). Selection of an instructional medium is indicated if (a) the instruction must be reproducible for a large audience, (b) it is to be self-paced, (c) the content is locked in (unchangeable), or (d) use of face-to-face instruction is impractical.

Selecting a stand-alone instructional medium requires most of the same decisions as selecting instructional aids to support an instructor-led presentation. However, the same decisions may lead to different classes of media.

2. Determine the required lesson characteristics and select an appropriate class of media. The users first determine whether the mode of learning is affective, cognitive, or psychomotor.

a. If the learning mode is affective, the users are directed to potential classes of media depending on whether the content deals with interpersonal skills, and whether the display of motion and/or sound is necessary.

b. If the mode of learning is cognitive or psychomotor, the users must determine whether the lesson involves objects or things unfamiliar to the student. If it does not, the users are directed to potential classes of media depending on whether interpersonal skills are involved, whether displays of motion and/or sound are involved, and whether demonstrating actual performance in class is practical (economical, safe, etc.).

c. If the lesson involves objects or activities unfamiliar to the student, the users are directed to potential classes of media depending on whether interpersonal skills are involved; whether displays of motion, sound, or color are involved; whether demonstrating the real object or activity in class is practical; and, if so, whether it is desirable to display exaggerated views or presentations.

3. Review a list of potential media for each media class and select an appropriate media class and medium within that class. No guidance is provided for performing this procedure.

4. Review statements concerning the advantages and disadvantages of the selected medium and to complete a checklist of items relevant to the use of the medium, student expectations, lesson content, and objectives. However, checklists are not provided for all of the media or media classes. Some of the checklists appear to address issues already dealt with in step 3. Issues that are considered (such as safety and economic factors) vary greatly from one checklist to another.

Users are instructed to accept or reject their initial choice based on the results of their review. Users who reject their initial choice are instructed to select one of the other media from the appropriate classes and repeat the procedure.

Outcome of Selection Process

At the conclusion of the selection process, each user has selected a single medium for use as an instructional aid or as an instructional medium.

Boucher et al. (1971)

Intended Users

This media selection decision aid is designed for use by training specialists.

Student Population

The target population for the instruction consists of Navy students.

Media Covered

This aid considers 29 specific media types. These media types include conventional media as well as simulators, teaching machines, and a few specialized systems designed for specific training purposes or utilizing combinations of media.

Format for Providing User Direction

User direction is provided by written text referenced to a matrix, worksheets, and lists of media and their features.

Procedures and Criteria

The aid directs users to:

1. Write a behavior, condition, and standard for each learning objective. No guidance is provided for this procedure.

2. Analyze each objective to determine training parameters that are relevant in presenting the instruction, forming an instructional strategy, and eliciting student responses. Lists of potential parameters provided by the aid include: (a) presentation parameters including visual, auditory, tactile, and kinesthetic cues; (b) instructional strategy parameters including repetition, knowledge of results, linear, branching, and adaptive; and (c) student response parameters including selection, specific, created, indication, manipulation, and gross body movement. A user worksheet for recording relevant parameters for each learning objective is mentioned, but not provided.

3. Review a "Media Capabilities Matrix," which rates the suitability of each of 29 generic media types for providing the listed parameters. On the basis of these suitability ratings, users are to develop a set of generic media candidates for each objective. The users are then directed to review each candidate media and select desired features.

4. A "Generic Media Section" in the text where each media type and its various available features are described. Users enter a set of "Data Grouping Sheets" and use a "Data Locator Card" to determine whether any specific medium can satisfy all of the required features. If more than one medium satisfies the desired features, a specific medium is selected based on costs. (The "Data Grouping Sheets" provide cost data for the year the description of the media selection aid was generated.)

Outcome of Selecting Process

At the conclusion of the selection process, each user has selected the least expensive medium that satisfies the training requirement.

Braby et al. (1975)

Intended Users

This media selection decision aid is designed for use by instructional designers having expert knowledge of media.

Student Population

The target population for the instruction consists of military students.

Media Covered

Two sets of media are provided. The first media set is categorized by type of learning. Each of 12 types of learning are assigned from 2 to 8 primary media delivery systems and from 1 to 5 alternative media delivery systems. Primary media systems fully support learning while alternative media systems only provide partial support. Each media delivery system consists of a single medium or a media mix.

The second media set consists of 89 specific media. Both sets of media range from conventional media to computers and simulators.

Format for Providing User Direction

User direction is provided by a formal three-step selection procedure referenced to matrices and supporting texts and tables.

Procedures and Criteria

The aid directs users to:

1. Classify and group training objectives according to the type of learning they represent. A table gives the characteristics of training objectives and specifies what type of learning is associated with those characteristics. The users determine the characteristics that are relevant to their training objectives and identify the associated type of learning.

2. Identify two or more types of media delivery systems that will support each training objective. To do this, users are referred to the appropriate type of learning table where a matrix lists special criteria that may be considered in selecting media and the media delivery systems that support those criteria. Special criteria may include any of a variety of stimulus, training, and administrative criteria unique to specific training programs. Stimulus criteria include stimulus characteristics such as video and audio cues, and trainee movement requirements. Training criteria include group size and location. Administrative criteria include cost and course development characteristics. Users are required to check the special criteria that are relevant to the training objectives. The media delivery systems that satisfy the greatest number of special criteria are selected as candidate systems.

If users wish to consider special criteria or media delivery systems not listed in the table, an alternative matrix may be constructed using the second set of 89 media. This procedure is only recommended for very experienced instructional media users.

The aid also directs users to compare the candidate systems in a test of practicality where the following 11 criteria are to be considered: (a) marginal technical solution, (b) state-of-the-art, (c) size of system, (d) interface with existing program, (e) time needed or available to produce system, (f) budget cycle constraints, (g) adoption of innovations, (h) courseware development, (i) high cost alternatives, (j) learning style of trainees, and (k) other constraints (such as command policy and existing investment in production facilities). The aid instructs the users to eliminate any candidate systems that do not meet these criteria, but provides no guidance for rating the candidate systems against the criteria.

3. Estimate implementation costs for each of the remaining candidate systems. Users are referred to a provided worksheet with detailed cost requirements and to record cost requirements for each remaining candidate system. (A Fortran IV program for computing these costs is available.)

Outcome of Selection Process

At the conclusion of the selection process, each user has selected the most cost-effective instructional delivery system or mix of systems for each training objective.

Bretz (1971)

Intended Users

This media selection decision aid is designed for instructional designers to use specifically with self-contained communication systems having reproducible software. (Supplementary media such as audio and visual aids, which only assist an instructor in presenting a lesson, are not considered.)

Student Population

The target population for the instruction appears to be any student audience.

Media Covered

The range of media is composed of eight classes of media (audio-motion-visual, audio-still-visual, audio-semimotion, motion-visual, still-visual, semimotion, audio, and print). Each class consists of from one to six media for a total of 31 specific media. Specific media vary from television and radio to sound-on-slides, filmstrips, and audio tapes. Users may combine classes of media to create other media classes.

Format for Providing User Direction

User direction is provided by text procedure referenced to a master flowchart and several supplementary flowcharts.

Procedures and Criteria

Media selection decisions are made in the following manner.

1. The aid requires users to determine whether communication media are appropriate by asking, "Is the presentation of sensory information, or the sending of verbal messages, involved?" If the answer is yes, the users are referred to the master flowchart to determine whether the objective is concrete (best expressed in audio and/or visual terms) or abstract (best expressed in language). The aid provides a supplementary flowchart to assist users in making this decision. The objective is considered "concrete-visual" if there is a requirement for: (a) visual recognition, (b) recognition or recall of a procedure, (c) the understanding of a two-dimensional relationship, or (d) a three-dimensional structure. The objective is considered "concrete-audio" if there is a requirement for: (a) specific sounds or (b) an appreciation of music or oral literature. Otherwise, the objective is considered abstract and best expressed in language.

2. To discriminate further between concrete objectives that are either audio or visual, the users are referred to another supplementary flowchart where they must consider the requirements for: (a) the degree of motion (from none to fast), (b) whether or not the objective involves the recognition or performance of a procedure, and (c) if the type of movement of a subject is an important characteristic. Resolving these issues leads the users to one of four possible media classes: audio-motion-visual, audio-still-visual, motion-visual, or still-visual.

3. If the objective is abstract, the users are referred to another supplementary flowchart to determine the means of conveying narration. Narration decision criteria are: (a) reading ability, (b) the need for the personal element (speaker's expression, hand

gestures, etc.), feelings, or attitude, (c) group versus individual, and (d) if oral or written language arts are being taught. The users' responses to these decision criteria, in turn, lead them to one of two additional flowcharts: (a) print narration and (b) audio or audio and print narration.

4. If the outcome is print narration, several classes of media are possible. To determine which of these media classes would be appropriate, the users answer the following questions: (a) Are abstract concepts and relationships involved which could be expressed graphically? (b) Is recall of a set of items required? (c) Is user overview of the outline of a discussion useful? (d) Is there any logical reason for using full motion, buildup (presentation of symbols in relation to concrete subjects), or pointing (coordinating visual presentations with audio narration)? The users' responses to these questions lead to selection of one of four possible media classes (print, motion-visual, semimotion, or still-visual).

If, on the other hand, the outcome is audio or audio with print narration, the users must still answer these questions but also indicate if familiar spoken words are related to unfamiliar written or printed ones. In this case, the users' responses lead to selection of one of four different media classes (audio, audio-motion-visual, audio-semimotion, or audio-still-visual).

5. Once a media class for each objective has been selected, the users are directed to review the selected classes and determine if the number of media classes can be consolidated to reduce the variety of required equipment. Examples of how classes can be consolidated are provided.

The aid also suggests considering practicality factors such as costs, resources, or constraints. No guidance is provided for performing this procedure.

Outcome of Selection Process

At the conclusion of the selection process, each user has selected a class of media for presenting instruction.

Collins et al. (1987) (Training Decisions System)

Intended Users

The Training Decisions System (TDS) situation/level decision aid is designed for use by manpower, personnel, and training communities personnel. It is an automated decision process designed to assist these personnel in determining what, where, and when to train first-term airman skills while also ensuring effective training at minimum cost.

Student Population

The target population for the instruction is Air Force enlisted personnel.

Format for Providing User Direction

The aid provides user direction by a menu-driven computerized system.

Procedures and Criteria

Data Base Development

Before TDS can be used as a decision aid, data bases must be established for each of the following subsystems.

Task Characteristics Subsystem (TCS). The TCS data base is composed of multiple elements. First, a preliminary list of all task training objectives must be entered into the system. The TDS can use the key task objective words to group the entered tasks into task training modules (TTMs). These groupings can also be established or revised by subject matter experts. This manual grouping capability allows parts of tasks to be grouped separately for training at different times and in different environments.

Second, training sites for each TTM are identified and added to the data base with resource information for each site. Resource information includes the: (1) types and numbers of equipment needed for the instruction and (2) the student-to-instructor ratio for the various training locations.

Third, the following TTM time estimates are developed for the data base: (1) the amount of time currently spent providing instruction, (2) the maximum amount of time desired to provide the instruction, and (3) the minimum amount of time needed for instruction under a contingency situation.

Field Utilization Subsystem (FUS). The current training path for each military occupational specialty (MOS) is entered into the FUS data base.

Resource/Cost Subsystem (RCS). The following types of data are entered into the RCS data base: (1) the annual recurring costs for equipment, (2) the number of instructors needed for the equipment, and (3) the student/instructor ratio.

User Procedures

For each training module, users must specify potential training locations and paths. For each training path, the TDS indicates training costs, times, and equipment and

provides graphic displays for each training path. Users can select the least expensive training path that meets their needs.

Outcome of TDS Selection Process

At the conclusion of the selection process, each user has selected a specific training path.

Gagne & Briggs (1974)

Intended Users

This media selection decision aid is designed for use by instructional designers.

Student Population

The target population for the instruction is any student audience.

Media Covered

The media choices are determined totally by the users.

Format for Providing User Direction

User direction is provided by a sequence of eight steps referenced to text material, tables, and a worksheet.

Procedures and Criteria

Users record responses to each of the following eight media decision steps on a provided worksheet. The aid directs users to:

1. Identify the lesson objectives and refers them to several text chapters to assist in this process.

2. Classify the lesson objectives in terms of the domain of learning outcome (mode of learning) and, if required, the subdomain (type of learning). The text includes a chapter for classifying objectives but the users are not referred to it.

3. List the instructional events to be accomplished during the lesson. The aid refers them to a text chapter to assist in this process.

4. Select the types of stimuli required for each objective and refers them to Dale's "cone of experience," which is briefly discussed in the text. Users are further instructed to consider the nature of the objective, the nature of the learner, and the particular instructional event being planned. No guidance is provided for selecting stimulus types on these three criteria.

5. List, for each instructional event, the candidate media which can convey the required types of stimuli (sound, color, motion, etc.). The users totally determine the range of media. The users are referenced to a few examples of types of stimuli and appropriate candidate media. The authors instruct the users to identify a range of candidate media and suggest that later the user may want to substitute other media or to reduce or enlarge the range of media, but they are unclear as to why or how to do this.

6. Select the "theoretically" best media even if it is beyond the available resources (time or costs). No guidance is provided for determining the best media.

7. Make a final media selection and to determine the practicality of using the theoretically best media. Users are instructed to consider 15 listed practical factors. These practical factors involve considerations of affective impact, adaptability to

conditions of learning and instructional events, availability, cost effectiveness, disruption, group size, programmability, range of viewing and hearing sequence flexibility, stimulus characteristic requirements, storage requirements, and teacher training requirements. Users have the option of adding additional factors to this list. The aid directs users to consider the nature of the learners and lesson objectives. In making practical factor decisions, users are directed to: (a) stay within the resources and constraints of the media developers and the classroom environment, (b) change media infrequently enough to promote efficiency but frequently enough to promote interest and effectiveness, and (c) use the capabilities of the media.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected a medium or media mix for each instructional event of the lesson objective.

Goodman (1971)

Intended Users

No specific users are identified.

Student Population

The target population for the instruction appears to be any student audience.

Media Covered

The media choices are determined totally by the user.

Format for Providing User Direction

User direction is provided by a sequence of nine steps.

Procedures and Criteria

The aid directs users to:

1. Identify and list anything the student is required to view, hear, or manipulate in performing the task.

2. List the media or media combinations that are not useful based on student characteristics (age, grade level, IQ, reading ability, physical characteristics, cultural background, attitudes, etc.). No guidance is provided for developing an initial list or media nor for relating media characteristics to student characteristics.

3. Rank the medium or media combinations according to their hypothesized effectiveness in providing for student viewing, hearing, or manipulating and in relating to student characteristics. No guidance is provided for making these rankings.

4. Determine the most useful methods of presenting each medium or media combination. To do this, the aid instructs users to consider the most effective "modes" (large group, small group, individual study, laboratory) in which the instruction could be conducted. Then, the users are to list specific methods for use with each medium or media combination. No guidance is provided for linking a method to a medium or media combination.

5. Determine if the media identified in step 4 are available or affordable and eliminate any media that do not meet these criteria.

6. Determine, for each of the media or media combinations, what presently available instructional materials would help the students accomplish specified behavioral objectives and what additional instructional materials would be useful. No guidance is provided for making these determinations.

7. Analyze the production capabilities and finances that are locally available for the production of additional useful instructional materials that are not commercially available. From this analysis, users are supposed to determine which of the needed instructional materials could be locally produced.

8. Rank order the remaining medium or media combinations in terms of their combined instructional and cost effectiveness. No guidance is provided.

9. Select the most cost-effective medium or media combination, again without guidance.

Outcome of Selecting Process

At the conclusion of the selection process, the user has selected the most cost effective medium or media combination for presenting instruction.

Holden (1974)

Intended Users

This media selection decision aid is designed for use by instructional designers.

Student Population

The target population for the instruction is any student audience.

Media Covered

Seven types of "software" are considered: printed text, audio tape, slides or filmstrip, synchronized tape with slide or filmstrip, 16mm motion picture, videotape, and computer program. The decision aid also includes a separate listing of hardware required to support the software.

Format for Providing User Direction

User direction is provided by a sequence of steps referenced to text material, matrices, and an example.

Procedures and Criteria

1. For each learning objective, users are directed to select a restriction rating for each of seven decision factors: (a) degree of control, (b) kind of learned capability, (c) cost, (d) flexibility of use, (e) population restrictions, (f) adaptability, and (g) compatibility with hardware. To aid in assigning ratings, the text defines each decision factor and assigns it ratings that reflect the "levels of restriction" that each factor might have relative to the learning objective. For example, the decision factor "population," has been assigned the following three ratings: (a) no restrictions, (b) language restrictions (either language spoken or intellectual level), and (c) logistic restrictions.

2. For each type of software, users are directed to delete the decision factors that do not meet the rating code (restriction criteria) established for decision factors in step 1. Users are referred to a "software selection" matrix that specifies restriction ratings for each of the seven types of software with respect to the seven decision factors.

3. The aid directs users to select those software types that have no decision factors deleted or, if all have some deleted, those that have the fewest.

4. If more than one type of software satisfies all decision factors, users are instructed to look for combinations of these remaining types of media software that might provide variety and optimize training effectiveness. A partial example of this process is provided.

5. If all of the software types have some decision factors deleted, users are directed to review the responses and decide if any of them can be changed. No guidance is provided for deciding which responses can be changed or how they should be changed.

6. If several potential types of software remain, users are instructed to opt for cost savings first and variety second. Ratings of cost restrictions are provided in the matrix.

7. The aid directs users to select hardware using the same procedures as performed for software selection. The user is directed to a hardware selection matrix. This matrix lists 5 decision factors (cost, compatibility between models, portability, life of equipment, and maintenance cost) that intersect with 11 types of hardware (4 types of projectors, 3 types of tape players, 2 types of video, 1 type of optical reader, and 1 type of computer). Additionally, the aid rates each decision factor (low, medium, or high) to indicate how appropriate it is relative to each type of hardware.

8. After inappropriate types of hardware have been eliminated, users are directed to consider the remaining hardware types in terms of their match with the different forms of software and the "universality" of their use. No guidance is provided for making these considerations. The aid also warns users not to use the acquisition cost of the hardware as a deciding factor without considering hardware maintenance costs and period of use.

9. Finally, the aid directs users to select a media system based on the software and hardware selections. At this point, if more than one choice exists, the aid indicates that the final decision may be made subjectively.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected a single medium or media combination for presenting instruction and specified both the software and supporting hardware components.

Kemp (1980)

Intended Users

No specific users are identified.

Student Population

The target population for the instruction appears to be any student audience.

Media Covered

The range of media is composed of eight categories (photographic print series, slide series, filmstrips, recordings, overhead transparencies, motion pictures, videotape recordings, and multi-image/multimedia). The media choices within each category are determined by the users.

Format for Providing User Direction

User direction is provided by a sequence of three questions and a written prescription, all of which are referenced to flowcharts and tables.

Procedures and Criteria

The aid directs users to:

1. Answer three questions: (a) Which teaching/learning pattern (presentation, individualized learning, or small group interaction) is most appropriate, considering the objective and the nature of the student group, (b) which category of learning experiences (direct realistic experiences, verbal or printed word abstractions, or vicarious sensory experience) is most suitable for the objective and instructional activity in terms of the selected teaching/learning pattern, and (c), if sensory experience is indicated or selected, which attributes of media are necessary or desirable. Limited textual guidance is provided in the instructions for answering these questions.

2. Users are then referred to an appropriate media selection flowcharts for the selected teaching/learning pattern. Each chart has up to three "levels." At each level, questions are asked about media attributes with answers to be based on responses to the initial three questions. Level one questions concern the type of experience required for the learner (real, vicarious or sensory, or verbal abstraction). Level two questions address the need for audio and/or visual stimulus, and level three questions consider whether still or motion displays are needed. Media choices are indicated based on responses to these questions.

3. When media choices lead to a group of related media, such as motion pictures, the aid directs users to choose the most practical form. To assist in this decision, they are referred to a table which lists nine empirical factors to use in comparing the various types of media. These include commercial availability, preparation costs, reproduction costs, time to repair, skills and services required, viewing and handling, maintenance and storage, student preference, and instructor preference.

4. The aid directs users to consider relative planning, production, and duplication costs. Users are referred to a table providing examples of how such costs can be documented and compared.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected a single medium or media mix for presenting instruction.

Kribs et al. (1983) (Automated Instructional Media Selection)

Intended Users

The Automated Instructional Media Selection (AIMS) decision aid is designed for use by instructional designers. Media specialists working together with educational specialists and subject matter experts could make optimum use of this decision aid.

Student Population

The target population for the instruction appears to be any student audience.

Media Covered

The media choices are determined totally by the users. Up to 99 different media can be compared at once. The AIMS system provides a list of 22 specific media for user consideration. These media vary from conventional media to simulators, and computer-assisted or computer-managed instruction.

Format for Providing User Direction

User direction is provided by a series of steps referenced to worksheets for rating media. These ratings are summarized in a computer data base. A "User Guide" is provided for entering information into the menu-driven computer data base program.

Procedures and Criteria

The aid directs users to:

1. Develop a list of media or combinations of potential media. They have the option of using a media list provided by AIMS. The final list of selected media is put into the AIMS media data base.

2. List all the instructional characteristics the media should address (such as the modes of learning, types of learning, stimulus characteristics, etc.). Again, users have the option of using an instructional characteristics list provided by AIMS. The final list of instructional characteristics is also put into the AIMS data base. From these data lists, the computer creates and prints a media-by-attribute worksheet. No guidance is provided for determining the completeness or appropriateness of either the media list or the instructional characteristics list.

3. Subjectively rate each medium or media combination (0-5) on its ability to deliver each instructional characteristic. These ratings are put into the computer. The AIMS system then sums the ratings and rank orders the media in accordance with their ratings. No guidance is provided for determining the rating values. In summing the ratings, all instructional characteristics are treated as being equally important.

Outcome of Selection Process

At the conclusion of the selection process, the users have generated a list of media and/or media combinations ranked according to their perceived appropriateness for presenting instruction for the given objective.

Leiblum (1980)

Intended Users

This media selection decision aid is designed for use by instructional technologists. The decision aid is specifically concerned with whether computer-assisted learning (CAL) is the most suitable medium for the solution of the instructional problem under consideration.

Student Population

The target population for the instruction appears to be any student audience.

Media Covered

The media choices are determined totally by the user.

Format for Providing User Direction

User direction is provided by a sequence of steps used in conjunction with a matrix worksheet and a list of learning delivery mechanisms.

Procedures and Criteria

The aid directs users to build a media selection matrix for each task or instructional event, taking into account any local limitations or requirements, in the following manner.

1. The aid directs users to enter available or easily accessible media that are to be considered as the column headings on a worksheet.

2. The aid directs users to examine six learning delivery mechanisms listed as row headings on the worksheet: (a) instructional event, (b) learner, (c) sensory modality (stimulus characteristics), (d) production, (e) distribution, and (f) other. Each delivery mechanism contains from four to eight specific attributes. Brief explanations of each learning delivery mechanism attribute are provided. For each medium to be considered, users are directed to indicate whether each attribute is (a) obtainable, (c) obtainable, but with difficulty, or (c) unobtainable.

3. The aid directs users to study each instructional task or event and identify and list (on a separate piece of paper) all behavioral objectives and/or critical behaviors. To do this, the users are instructed to obtain required documentation.

4. The aid directs users to assign a weighting factor (WF) for each attribute according to its relative importance in achieving the critical behavior and to enter it on the worksheet.

5. The aid directs users to multiply the attribute WF by the obtainability rating of the medium to get an overall score.

6. The aid directs users to determine whether the medium with the highest score can provide all of the essential attributes. If it cannot, an alternative medium or media mix must be selected. To determine alternative media, the users are directed to identify

those media with the highest totals and select a medium or media mix that provides all the essential attributes.

Outcome of Selecting Process

At the conclusion of the selection process, the user has selected a single medium or a media mix for presenting instruction.

Levie (1975)

Intended Users

This media selection decision aid is designed for use by instructional developers.

Student Population

The target population for the instruction appears to be any student audience.

Media Covered

The media choices are determined totally by the user.

Format for Providing User Direction

User direction is provided by a four-step flowchart referenced to text instructions.

Procedures and Criteria

In selecting task objectives, the aid suggests that users deal with small tasks and be exact about the class of instructional event or type of learning objective involved. Users make media selection decisions in the following manner.

1. The aid directs users to determine the required media attributes for each objective. The aid describes five media attribute categories: sign vehicle characteristics (e.g., words vs. pictures), realism cue characteristics (e.g., color vs. black and white, motion vs. still), sensory channel characteristics (e.g., seeing vs. hearing vs. seeing plus hearing), loci of control characteristics (e.g., fixed vs. flexible pace or sequence), and response acceptance characteristics (e.g., overt vs. convert responding). No guidance is provided for determining which of these attributes apply to the learning objective.

2. To determine media candidates, users are directed to analyze what the aid refers to as the "non-media components" of the instructional situation. Non-media components include: (a) learning task analysis, (b) learner analysis, and (c) an analysis of the learning environment. (The aid assumes that non-media decisions have previously been determined.) Examples of how to base media decisions on non-media components are provided. For example, the aid states that an auditory medium should not be used for deaf learners. No further guidance for identifying media candidates from non-media components is provided.

3. The aid directs users to apply pragmatic constraints. The aid states that there are two "real world" constraints: production constraints, which are associated with creating the first copy of the instructional product and dissemination constraints, which are associated with making and delivering multiple copies to the places where they will be used. The aid lists and briefly discusses six production and six dissemination constraints to guide the users in assessing the practicality of each medium on the alternative media list. No further guidance for applying pragmatic constraints is provided.

4. To make a final choice, the aid directs users to choose the medium that (a) most closely approximates the conditions in which the learner will be expected to perform, (b) allows the learner to respond in the same manner as in the criterion situation, and (c) allows the learner to make the largest number of relevant responses in a given period.

The aid cautions users against automatically selecting the latest "in" medium. No further guidance is provided for the final selection of media.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected a single medium for presenting the instruction.

Lonigro & Eschenbrenner (1973)

Intended Users

This media selection decision aid is designed for use by media specialists and training managers of technical/vocational education.

Student Population

The target population for the instruction consists of technical/vocational students.

Media Covered

Eight media types are considered: still pictures/graphics, motion pictures, television, simulation, audio recordings, programmed instruction, tape/slide, and computer-assisted instruction.

Format for Providing User Direction

User direction is provided by a sequence of five steps referenced to text material, a matrix, worksheet, and examples.

Procedures and Criteria

The aid directs users to:

1. Determine which of five types of learning comprise the job task: (a) learning factual information, (b) learning multiple discriminations, (c) learning principles, concepts, and rules, (d) learning procedures, and (e) learning to perform skilled perceptual motor acts.

2. Specify the proficiency level required for each task (high, partial, or low). Proficiency definitions are provided but no guidance is provided for determining proficiency requirements.

3. Develop a list of media that would ensure achievement of the instructional objective. To develop this list, the aid provides users with a matrix that crosses eight types of media with the five types of learning. Each type of media is rated according to the proficiency it provides for each type of learning (high partial, or low). Users are instructed to list the media types from the matrix that meet or exceed the proficiency requirements for the type of learning that the task involves.

4. Specify an acceptable level of production costs that includes costs for equipment, supplies, facilities, and personnel. A table lists relative cost ranges of the eight media in five levels from low to high. Users may add additional cost production considerations to the table.

5. Select the most cost-proficient medium. Users are referred to a "gameboard" worksheet on which to plot the position of potential media in terms of costs and proficiency. Users then select the medium that provides the highest proficiency at the lowest cost. The aid indicates that selected media should provide at least a partial proficiency rating at no more than moderate costs. Media choices that provide high proficiency at high costs require further study before selection. No basis is provided for

determining when to select high cost/high proficiency media or for selecting media if all of the choices are given low proficiency ratings.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected the single most cost-proficient type of medium for presenting the instruction.

The Marine Corps Systems Approach to Training User's Guide (Draft) (1987)

Intended Users

Although the media selection decision aid was designed by the Marine Corps, no specific Marine Corps users are identified.

Student Population

The target population for the instruction appears to consist of students enrolled in Marine Corps Development and Education Command formal schools.

Media Covered

A total of 15 specific media are considered. These media vary from simple charts and posters, conventional films, and terrain model boards to the more sophisticated media technology such as simulators, computer-assisted instruction, and videodiscs.

Format for Providing Direction

User direction is provided by a written selection procedure with references to a series of tables.

Procedures and Criteria

The aid directs users to:

1. Categorize terminal and enabling learning objectives according to the general kind of learning (mode of learning) they represent (affective, cognitive, or motor). However, in order to use the tables provided, users must categorize training objectives according to the specific type of earning behaviors (type of learning) that are involved (for example, remembering facts, making decisions, or manipulating equipment controls).

2. Identify sets of potential media based on (a) the learning behaviors and (b) the training content. However, no guidelines for choosing media in terms of training content are provided.

3. Review lists of training methods and media characteristics. The apparent purpose of this review is to determine which media are appropriate for the training methods to be used and which media characteristics are desirable. Listed methods include action images, brainstorming, buzz groups, case studies, computer-assisted instruction, demonstrations, discussions, embedded training games, in-basket exercises, job aids, lectures, modeling, peer mediated learning, practical application, programmed instruction, related readings, roleplay, and simulation. However, no basis is provided for selecting training methods or for relating media characteristics to training methods or to any of the previously identified characteristics of the training situation.

4. Make a tentative media selection decision based on the kind of learning and the type of training content. No guidance is provided for choosing media based on training content.

5. Modify the selected media set based on specified physical and academic characteristics of the target population and the available resources (personnel, equipment,

facilities, and time). No direction is provided for modifying the selected media sets based on these criteria.

In addition to these selection criteria, coded lists of functional attributes of media and media characteristics are provided that can be used to identify desirable media and methods of presentation. However, no guidelines are provided for using these lists or for integrating functional attributes with other criterion in selecting media.

6. Make a final selection based on experience or preferences.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected several possible media from which a final choice of media can be made.

Media Selection (1974)

Intended Users

No specific users are identified.

Student Population

The target population of the instruction appears to be any student audience.

Media Covered

The media choices are determined totally by the user.

Format for Providing User Direction

User direction is provided by a six-step text procedure referenced to examples.

Procedures and Criteria

The decision aid requires users to identify lesson learning objectives before using the aid. No guidance is provided for this procedure. The aid directs users to:

1. Identify the potential media for presenting the instructional materia. Users are advised to consider three guidelines:

a. Special signal needs (content stimulus characteristics) such as audio or visual attributes.

b. Media with costs within the range of available funds. The aid reminds users to include expenses attached to production, operation, and maintenance costs. At this point, several potential media are to be identified and their relative costs compared.

c. The changeability of content areas (frequency of modification requirements).

At the end of step 1, users are expected to have developed a list of media they are willing to consider based on the three guidelines. However, no basis is provided for determining which types of media might satisfy the guideline requirements.

2. Eliminate any media that cannot be justified in terms of cost and time expenditures, availability of professional and technical assistance, functioning staffs, and faculty. Again no guidance is provided for eliminating media on the basis of these considerations. By the end of step 2, users have narrowed their list of media to those they are willing to consider.

3. Eliminate or combine media on the basis of basic instructional needs. Users are instructed to (a) identify the basic instructional needs to be satisfied, (b) determine how well each prospective medium meets those needs, and (c) eliminate any media that cannot meet those needs. To determine whether selected media satisfy basic instructional needs, a worksheet is provided that identifies basic or essential instructional capabilities. These include introductory capabilities (objectives, motivation, etc.) expository capabilities (generalities, supporting explanations, etc.) inquisitory capabilities (practice, test, etc.)

and flexibility and adaptiveness capabilities (identification of learner needs and dynamic modifications and helps). No further guidance is provided for performing this step. However, examples of media are provided before and after being combined. Users are instructed to rate the media in terms of introductory, expository, flexibility, and adaptiveness capabilities.

4. Construct a media selection algorithm and apply it to all objectives. An example of a media selection algorithm is presented as a flowchart of questions with yes/no responses. In the example, factors addressed include the level of learning (familiarization or instructional) mode of learning, stimulus characteristics, type of learning, simulation requirements, and interaction requirements. Responses to the questions lead to the selection of one or more of the listed media options. No guidance for developing the algorithm is provided.

5. Consolidate media within lessons where different media have been selected for different objectives and it is practical to reduce the types of media required. The stated purpose is to prevent over-mediation of the students. No guidance for consolidating media is provided.

6. Reexamine selections for the entire hierarchy and revise where necessary. No guidance is provided.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected a medium for presenting each instructional objective.

Merrill & Goodman (1972)

Intended Users

This media selection decision aid is designed for use by public school teachers, administrators, and curriculum specialists.

Student Population

The target population for the instruction appears to consist of public school students.

Media Covered

The range of media is composed of six categories: objects, still pictures, motion pictures, audio material, written material, and combinations of media. Each category consists of from three to seven media. A total of 22 specific media are considered. Specific media are limited to conventional delivery systems such as filmstrips, models, and commercial 16mm films.

Format for Providing User Direction

User direction is provided by a systematic five-step, partially proceduralized selection guide which references tables and written guidelines.

Procedures and Guidelines

To use the guide, terminal and enabling objectives must be identified and training strategy prescriptions planned for each objective. Media selection decisions are made in the following manner.

1. Users write a statement of the instructional outcome including a description of the audience, the behavior to be performed, the conditions under which the behavior will be observed, and the degree of acceptable performance (the elements of a performance objective). A description and example of each of these elements are provided.

2. Users determine the appropriate domain (mode of learning) for each objective. Written descriptions and examples of each domain are also provided.

3. For each objective, users determine the specific instructional/learning strategy (type of learning) that is appropriate within the specified domain. Written guidelines and lists indicate the instructional/learning strategies that may occur under each domain. Definitions and examples of each instructional/learning strategy are also provided.

4. For each objective, users write a strategy prescription for each training function (instructional event); that is, how the objective is to be presented, practiced, and evaluated. The strategy prescription indicates, for each training function, what kinds of information will be provided to the student and what kinds of responses the student will be required to make. Again, written guidelines and examples as well as printed worksheets to assist in entering data are provided. However, users must determine which strategies are appropriate for each type of training content.

5. Users are required to write separate media prescriptions for each training function (evaluation, practice, and presentation) taking into account the objective,

instructional/learning strategy, and any special student needs. No guidance is given for identifying student needs.

Users are directed to a separate set of media tables for each training function. They are instructed to select a media category for each of the three training functions by reading a description of each category and determining which is the most appropriate for the instructional/learning strategy involved.

Once a media category has been selected, the aid refers users to charts that list media in the identified media category and their key attributes. Users select the medium or media combination that best meets the requirement of the media prescription. Examples of the selection process and worksheets are provided.

Outcome of Selection Process

At the conclusion of the media selection process, the user has selected a medium or media combination for presenting instruction for each training function of the objective.

Methods/Media Selection Guidelines (1977)

Intended Users

The Naval Air Maintenance Training Group (NAMTRAGRU) decision aid is designed for use by NAMTRAGRU course development and training personnel.

Student Population

The target population for the instruction consists of NAMTRAGRU students.

Media Covered

The range of media is composed of nine categories. Each category consists of from one to four specific media. Specific media vary from conventional media to trainers and simulators.

Format for Providing User Direction

User direction is provided by a sequence of steps referenced to tables and/or lists.

Procedures and Criteria

Although not stated, the procedure assumes that users have developed a list of training objectives. The decision aid is separated into two parts: selecting an instructional method and selecting a medium. The aid directs users to:

1. Select an instructional method for each objective.

a. For each objective, users are directed to choose one or more instructional methods for each of three stages of learning (stages of training) using a stage of learning by instructional method matrix.

b. Users are referred to an appropriate instructional method table that defines the method and provides appropriate conditions for its use, qualifications for its applications, and guidelines for using the method. The conditions may indicate the stage of learning, level of performance, type of learning, mode of learning, function of media, level of student ability, etc. for which the method is recommended. Not all conditions appear in every instructional method table. Users compare the recommended methods and select one.

2. Select a medium or media mix.

a. Users are directed to classify and group the learning objectives into one of eight listed types of learning.

b. Users are directed to select two or more candidate media for each type of learning by using a media selection decision tree and a matrix that compares the effectiveness of instructional media for different types of learning. Users are guided through the media selection decision tree by yes/no responses that consider the following criteria: content stimulus characteristics (audio, visual, and written), function of media (practice and simulation), and simulation fidelity. This process identifies one or more appropriate categories of media for the objective. Users then use the matrix that

compares the effectiveness of instructional media for different types of learning to determine the relative effectiveness of the selected media category (low, average, or high). No guidance is provided for relating the method and media selection processes.

c. Users are directed to estimate the cost of using each candidate category of media to train the required number of students to meet the objectives. A table gives approximate costs, advantages/disadvantages, and uses for specific types of media.

d. Users are directed to identify the most cost-effective medium that meets both the instructional method and type of learning requirements. A table specifies (1) specific types of media for each category, (2) the approximate hardware and/or software costs, (3) production time, and (4) whether or not the software can be locally produced. However, no guidance is provided for performing this step.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected either a single medium or a media mix for presenting instruction.

Nonpersonnel Studies and Analysis Services for Assessment of New Training Technologies (1985)

Intended Users

This media selection decision aid is designed for the Air Force to use for replacing traditional instruction with advanced technology training delivery (ATTD) systems.

Student Population

The target population for the instruction consists of Air Force students.

Media Covered

Six specific media are considered: computer-based training, intelligent computer-assisted instruction, interactive videodisc, maintenance simulators, embedded training, and advanced job performance aids.

Format for Providing User Direction

User direction is provided by a combination of text procedures, charts, worksheets, and formulas.

Procedures and Criteria

User direction procedures employ the Multi-Attribute Utility Analysis (MAUA) (Keeney & Raiffa 1976). Procedures are described in terms of an example. The steps in the example are as follows.

1. The overall number of students per year, number of students per class, and number of hours of instruction per student must be specified for the user. Also, general training situation/level information (such as level of student education, whether the training is preliminary or advanced, etc.) must be determined for or by the user since this information is required in the decision process.

2. Potential media that are not appropriate for the training situation/level or are not sufficiently "mature" to be used at this time are rejected. No guidance is provided for these decisions. Student learning objectives are also to be provided to the user at this time.

3. The aid directs the user to determine training costs. The Instructional Systems Development (ISD) process is examined to determine the relative costs and effectiveness of each of the remaining media. (In practice, media only vary in cost for the development and implementation steps of the ISD process; so only those two steps are considered.)

Costs for the development of each of the media are determined from a table of estimated costs. Implementation costs are determined by the users. A provided listing of types of potential implementation costs consists of staffing/training, facilities requirements, hardware, software, and the scheduling/updating of courseware. For each type of cost, a number of considerations are listed.

Many costs would not be expected to vary with the type of medium. In practice, only those costs that would be expected to vary are considered. Also, the costs of

equipment or materials already available are not counted. For example, if computer terminals are already available, no acquisition cost for computer terminals would be included. After all development and implementation costs have been estimated, they are totaled to obtain the final cost for each medium.

4. The aid directs the user to determine training effectiveness by listing presentation "features" that are relevant to the training content and then rating each potential medium on its strength for each feature. Any number of relevant features might be considered. The example includes features such as degree of interaction, individualization, and ease of updating materials. However, it is not completely clear how to determine relevant features. Users are referred to a table of 10 factors that might be considered in selecting media. These factors include increased control, reduced resource requirements, individualization, timeliness and availability, reduced training time, improved job performance, convenience, change agent, increased learning satisfaction, and reduced development time. However, at least some of the features listed in the example do not appear in the table of factors. The derivation of those features is unclear. Also, the aid provides no guidance for determining which factors are relevant to a particular instructional setting or content.

In rating potential media for effectiveness, a total of 100 points is assigned to each feature. Users divide the 100 points among the prospective media based on how effective they perceive each medium to be for that feature. For example, if two media are being considered, a user might assign 50 points to each, 60 to one and 40 to the other, etc. Users also weight each feature in terms of its relative importance. Since the sum of all the weights must add up to 1.00, each feature is assigned some decimal portion of that value (.2, .05, etc.).

Next, feature scores are computed for each medium by multiplying the feature's weight by the assigned rating for that medium. For example, suppose computer-based instruction is assigned a rating of 50 for the feature "individualization" and individualization is assigned a weight of .12. The score for computer-based instruction on the individualization feature is then 50 x .12 = 6. Finally, a total score is computed for each medium by summing its feature scores.

5. The aid directs users to identify the most cost-effective medium. After cost and effectiveness scores are totaled for each medium, they are plotted on a graph with effectiveness on the vertical scale and costs on the horizontal scale. A medium high score in effectiveness and a low score in cost are considered to be desirable. However, how to select a medium if one is lower in cost but another is higher in effectiveness is not explained.

In addition to the procedures described above, this aid provides a number of tables that appear to be relevant to media selection but are not referenced in the procedures. One table indicates which media are appropriate for specified "instructional strategies" (drill and practice, simulation, problem analysis, etc.) and specifies related developmental costs. Another table lists strengths and weaknesses of media in terms of certain "characteristics." These characteristics appear to relate to the features that are considered in developing effectiveness ratings. Another table lists strengths for each of the considered media and gives some general types of training situations or content for which they would be appropriate. Another table lists instruction, management, and testing applications which should be considered in selecting media. No indication is given as to how these tables should be employed in selecting media.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected the most cost-effective medium for presenting the instruction.

Pieper et al. (1978) (Training Developer Decision Aid)

Intended Users

The Training Developer Decision Aid (TDDA) is designed for use by training development specialists (TDS).

Student Population

The target population for the instruction consists of Army enlisted personnel.

Media Covered

The 14 specific media considered vary from conventional media to programmed text, real equipment, and simulators.

Format for Providing User Direction

User direction is provided by a text description of the development and use of the TDDA process.

Procedures and Criteria

Although not stated, the TDDA assumes that the user has developed a list of training objectives. The TDDA process is composed of three "partitions": (1) training prescriptions, (2) training hierarchies and sequences, and (3) training costs. Users make selection decisions in the following manner.

1. In partition one, a training prescription is developed for each task. A training prescription consists of a (a) training algorithm, (b) stimulus medium, (c) response acceptance mechanism, (d) training method, and (e) training setting. The aid directs the users to:

a. Select one of 12 listed training algorithms to meet the task objective. The aid states that the verb used to describe the task should be used in selecting an appropriate training algorithm.

b. Select one of five classes of stimuli (verbal, audio, visual, audio-visual, or tactile) based on yes/no answers to 15 "stimulus questions."

c. Select one or more of four classes of responses (equipment manipulation, voice, written, or body movement) based on yes/no responses to 14 response acceptance questions.

d. Select a compatible stimulus media and response acceptance mechanism. Users are provided with lists of 15 training methods, 10 stimulus media and 14 response acceptance method mechanisms. To determine the characteristics common to the method and stimulus media, users assess them in terms of the pacing controller, stimuli content, and the next learning activity (sequence controller). To determine the characteristics common to the method and the response acceptance mechanisms, users assess them in terms of the pacing controller, type of evaluation, feedback, and next learning activity. The purpose of this procedure is to select a method that best satisfies the three characteristics of the stimulus medium and the four characteristics of the response

acceptance mechanism. However, it is not clear how these decisions are to be made. Users are also instructed to ensure that the task verb of the algorithm is appropriate for the method. The author notes that a list of the methods that are compatible with each algorithm has been developed. However, the list is neither in the text nor referenced.

e. Determine the training setting. Users are provided with a flowchart requiring yes/no responses to questions about the number of students, the nature of student interactions (individual/team), and whether or not the task is equipment related. The outcome of this flowchart indicates one of five possible training settings (small team site, large team site, individual carrel, small group carrel, or traditional classroom).

2. In partition two, training hierarchies and sequences are established. The aid directs users to:

a. Identify equipment and supporting equipment (test equipment, etc.) for each task and each pay grade level. (This assumes the task involves equipment maintenance or operation.)

b. Assign each task a training priority. To assign priorities, users must rate the task in terms of (1) how long after initial training the soldier will be expected to perform the task, (2) its contribution to the systems's mission, (3) a combination of time to application and task learning time, (4) the percentage of members performing the task, and (5) the percentage of time spent performing the task.

c. Assign tasks to training periods. To do this, users must determine (1) total training time available for each training option and (2) required training times for individual tasks. The highest priority tasks are assigned to resident formal school training until the total amount of resident training time is used up. The next highest priority tasks are assigned to on-the-job training (OJT) until OJT training time is used up. Any remaining tasks are not trained.

3. In partition three, costing procedures are used to determine training costs for resident training and OJT. To determine these costs, users are directed to consider numerous variables such as the number of hours available in a learning cycle, the number of hours required to learn the tasks, and the percentage of nonproductive time (used for unit movement, deployment, or other nontraining activities, etc.). The training method is also used as a factor in determining costs. Cost rankings are provided for each training method (previously identified in partition one).

Outcome of Selection Process

At the conclusion of the selection process, the user has selected a training situation, media, and method for presenting instruction and determined the relative costs.

Reiser & Gagne (1983)

Intended Users

This media selection decision aid is designed for use by instructional designers.

Student Population

The target population for the instruction seems to be any student audience.

Media Covered

The 20 specific media considered vary from conventional media to actual equipment, simulators, training devices, and interactive TV.

Format for Providing User Direction

User direction is provided by a flowchart.

Procedures and Criteria

Users make media selection decisions in the following manner.

1. Although not stated in the media selection decision aid itself, prior to using the decision aid, each learning objective must be classified into one of five domains of learning outcomes (modes of learning) and the instructional setting (location and group size) must be determined. No guidance is given for determining any of these prerequisite data. However, the aid's authors indicate that different domains of learning outcomes require certain types of feedback capabilities and that some media are more appropriate for providing these capabilities than are others.

2. At the first decision point in the flowchart, users are required to determine whether or not an error in the actual performance of the task has serious consequences. If the consequences are serious, the users must select a medium for practicing the task from a list of media options. Users are then directed to proceed to the second decision point (whether or not a practice medium is required).

3. At the next decision point, users are required to determine whether or not the training should be (a) centrally broadcast, (b) self-instructed (with readers or nonreaders), or (c) led by an instructor (with readers or nonreaders). For each of these conditions, users are directed to sets of potential media based on the domain of learning outcome (attitude, verbal information, mental skill, or motor skill) and the need for visuals. For self-instruction with nonreaders, feedback requirements are also considered.

Outcome of Selection Process

At the conclusion of the selection process, the user has selected a specific medium, a choice of media, or a mix of media for presenting instruction.

Romiszowski (1974)

Intended Users

This media selection decision aid is designed for use by teachers and lesson designers.

Student Population

The target population for the instruction is any student audience.

Media Covered

The 16 general types of media considered vary from live commentary and written text to special training devices and simulators.

Format for Providing User Direction

User direction is provided by a sequence of steps referenced to flowcharts and text descriptions.

Procedures and Criteria

1. The aid directs users to define the behavioral objectives for each topic. No procedures are provided for performing this step.

2. The aid directs users to prescribe the instructional event for each objective. No procedures are provided for performing this step. However, the aid suggests that the instructional events should be expressed in terms of stimulus and response requirements so that these requirements can be matched later with media attributes.

3. The aid directs users to assess (a) the type of responses required of the students, (b) the type of stimuli required to communicate the message, and (c) the student group characteristics. Users are provided with flowcharts for identifying each factor. Each flowchart identifies one or more media that satisfy the specified requirements.

a. Type of responses required. To identify the type of responses required of the students, users must consider whether motor repsonses or perceptual skills are involved, how new the task is to the student, whether the normal job situation would give clear feedback on progress, and how complex any verbal responses are.

b. Type of stimuli required. To identify the type of stimuli required to communicate the message, users must first consider visual aspects such as (1) whether or not the task deals with concrete observable objects or effects, (2) if important aspects of the object are hidden or obscured, (3) if the object is available, (4) the size of the object, (5) if three-dimensional stimuli are required, and (6) if students must learn to recognize or duplicate motions or actions.

Users must then identify verbal and sound stimuli required to communicate the message by considering (1) whether or not sound is an integral part of the topic, (2) whether verbal communication is the main objective, (3) if the topic is complex or abstract, (4) whether the audio content can be prepared as a script, and (5) whether the topic is taught regularly without change.

c. Student group characteristics. To identify the characteristics of the student group, users must first decide if they control the class size. If not, media based on group size and individualization of study are prescribed. If users control group size, they must consider if the training objective requires full retention and is easily retained or if it is of higher order (e.g., discrimination, concept, or rule) and involves social skills, psychomotor skills, or perceptual training.

4. The aid directs users to list all the media identified in step 3 that satisfy the specified requirements. Any media that are unsuitable due to environmental constraints are identified by answering six yes/no questions. These questions address (a) whether or not the media identified are obtainable, economical in regard to payoff, student-proof, and maintainable/repairable; (b) if space is available for them; (c) if logistics support (power supplies, etc.) are available; and (d) if they will have a reasonable amount of use before subject matter changes render the medium obsolete. Any medium with a "no" answer is deleted. From the revised list, users delete any medium unlikely to suit the students due to learning habits, past experiences, or psychological characteristics. To do this, users are referred to the text for a discussion of learning task factors and student factors.

Next, users are directed to assess whether or not each medium satisfies the task and student factor requirements. Little guidance is provided for this fairly subjective procedure. At the completion of this step, the user's media list should be reduced to a few candidate choices.

5. The aid directs users to select a final medium or media mix. Users must consider the (a) personal preferences of the teachers and (b) desirability of using the same media for different training objectives.

Outcome of Selecting Process

At the conclusion of the selection process, the user has identified single medium or media mix for presenting instruction.

User's Manual for Predicting Military Task Retention (1985)

Intended Users

The User's Manual for Predicting Military Task Retention (UMPMTR) situation/level decision aid is designed for Army unit trainers to use in determining how frequently specific military occupational specialty (MOS) tasks require refresher training to maintain a specified level of proficiency.

Student Population

The target population for the decision aid consists of Army enlisted personnel who have been previously trained to proficiency on a specified task.

Format for Providing User Direction

User direction is provided by a sequency of three steps. User direction may be provided by a User's Manual or a computer-based User's Decision Aid (Apple software and IBM Basic).

Procedures and Criteria

The development and use of a UMPMTR data base to determine refresher requirements consists of two steps, the development of a data base and the determination of retention predictors.

1. Data Base Development. The purpose of step 1 is to rate the retention difficulty of each MOS task. Step 1 is performed by SMEs who are familiar with the MOS tasks for which instruction is to be developed. SME raters complete a 10 question algorithm to assign each task a retention score.

2. Retention Prediction Determination. Step 2 may be performed by any user and does not require SME inputs. The user is directed to determine the no-practice interval; that is, time that has elapsed since the task of interest was last practiced. The user is then referenced to a performance-prediction matrix on which task retention scores intersect with length-of-time-without-practice to give a retention prediction value. This value indicates the percentage of soldiers in the unit that can perform the task correctly after a specified time period without practice. Given the task retention score for a task and the no-practice interval, the user can determine what percentage of the personnel are likely to have retained the task. Based on this percentage, users or other decision makers can determine whether retraining on the task is required at this time.

Outcome of PMTR Process

At the conclusion of PMTR process, the user has determined the refresher training intervals required to ensure specified levels of unit proficiency for each task.

Walker (1965)

Intended Users

This media selection decision aid is designed for the "training man."

Student Population

The target population for the instruction is any student audience.

Media Covered

A total of 16 "training techniques" are considered. (The author apparently uses the term "training technique" to cover a mixture of methods and media.) These techniques vary from lectures and texts to sleep teaching and simulators.

Format for Providing User Direction

User direction is provided by written text referenced to a matrix and an example.

Procedures and Criteria

This decision aid assumes that, prior to the selection of a training technique, a task analysis has been completed and other relevant information such as instructor availability, class size, number of trainees, and training location have been established. Training techniques are selected in the following manner.

1. Users are directed to develop, for each objective, a list of criteria important to the selection of a training technique. Examples of criteria include the type of learning, updating requirements, costs, preparation time, and availability of instructors.

2. Users are referenced to a "Selection Criteria Matrix," which lists 34 selection criteria that intersect with 16 training techniques. Each technique has been given a desirable relationship rating (1-5) for each criteria. The selection criteria are categorized as either management-centered (such as time to produce, effectiveness of teaching motor skills, cost to teach, student intelligence, etc.) or student-centered (such as student motivation, reinforcement, feedback retention, pace, etc.). Users are directed to identify the criteria in the matrix that match those established in step 1.

3. Users are then directed to sum the ratings of all student-centered criteria and all other criteria they identified as relating to the objective. Users are directed to rank order the desirability of each training technique based on these sums. No guidance is provided for ranking user identified criteria not identified in the matrix.

4. Users are then directed to select the technique with the highest overall rating for application. However, before selecting a training technique, users are instructed to make sure that its training effectiveness justifies its cost. No guidance is provided for this procedure.

Outcome of Selection

At the conclusion of the selection process, the user has selected a single training technique for presenting instruction.

APPENDIX B

CROSS-REFERENCE TO DECISION AID EXAMPLES

CROSS-REFERENCE TO DECISION AID EXAMPLES

This report provides recommendations for the development of military training decision aids. Although none of the reviewed training decision aids satisfy all of the recommendations made in this report, many of the procedures and criteria this report has advocated have been applied in these aids. The following cross-reference indicates examples of existing training decision aids that provide procedures or criteria cited in these recommendations. Indicated aids should be referenced as examples in developing training decision aids for military users. Descriptions of all referenced training decision aids are provided in Appendix A. Complete references for each of these aids are provided in the reference section of this report.

1. Develop training decision aids for specific military applications.

The following are examples of training decision aids developed for specific military applications.

a. Aids for users establishing training situations/levels.

(1) An aid for assisting military personnel in the initial establishment of training situations/levels was developed by Pieper, Guard, and Kordek (1978). However, its procedures are complex and should be simplified.

(2) An aid for assisting military personnel to compare the cost effectiveness of different training sites was developed by Collins, Hernandez, Ruck, Vaughn, Mitchell, and Rueter (1987).

(3) An aid for assisting military personnel to determine refresher training periods was developed by the Army (User's Manual for Predicting Task Retention, 1985).

b. Aids for users selecting media.

(1) Aids for assisting military instructors to select media were developed by the Marine Corps (The Marine Corps Systems Approach to Training User's Guide (Draft), 1987) and the Navy (Methods/Media Selection Guidelines, 1977). However, neither of these aids concentrates on the needs of instructors and neither is adequate in terms of the format and criteria utilized, the clarity of the procedures, and the level of guidance provided.

(2) An aid for assisting military course designers or planners to select media developed by Braby, Henry, Parrish, and Swope (1975). Again, however, the format, criteria, and procedures are inadequate.

(3) An aid for assisting military personnel to replace conventional instruction with new technologies was developed by the Air Force (Nonpersonnel Studies and Analysis Services for Assessment of New Training Technologies, 1985). Again, however, the format, criteria, and procedures are inadequate.

2. Combine computerized flowchart and matrix formats in structuring decision aids.

This report recommends combining flowchart and matrix formats in establishing training situations/levels or selecting media, which none of the reviewed training

decisions aids does. However, examples using flowchart formats are provided by Anderson (1983), Bretz (1971), Levie (1975), Reiser and Gagne (1982), and Romiszowski (1974). Examples using matrix formats are provided by Braby et al. (1975), and Walker (1965).

This report also recommends computer automation of selection procedures. An automated training decision aid for determining the cost effectiveness of alternative training sites was developed by Collins et al. (1987). An automated aid for determining refresher training was developed by the Army (User's Manual for Predicting Task Retention, 1985).

The only automated media selection aid reviewed in this report was developed by Kribs, Simpson, and Mark (1983). However, this media selection system is considered inadequate in terms of the level of direction provided to the user.

3. Provide detailed guidance for training decision aids.

Aids with strong user guidance for establishing training situations/levels were developed by Pieper et al. (1978) for initial selection of training sites, Collins et al. (1987) for cost comparisons of training sites, and the Army (User's Manual for Predicting Task Retention, 1985) for determining periods for refresher training.

Examples of aids with strong user guidance for selection of media are provided by Reiser and Gagne (1982) in a flowchart format, Wagner (1965) in a matrix format, Braby et al. (1975) for analyzing costs, and the Air Force (Nonpersonnel Studies and Analysis Services for Assessment of New Training Technologies, 1985) for comparing the cost effectiveness of new technology.

4. Develop decision aids for specific types of tasks.

Examples of aids using the task as the unit of training are provided by Kribs et al. (1983), Leiblum (1980), Levie (1975), and Lonigro and Eschenbrenner (1973). None of the reviewed aids use functional areas or task types as the unit of training. However, Braby et al. (1975) provides specialized media selection models for different types of learning. Conceivably, similar types of specialized media selection models could be constructed for different functional areas or task types.

5. Select training situations/levels based on training priorities, task prerequisites, training time, task appropriateness, and training costs.

Training priorities, task prerequisites, and training time are discussed in Pieper et al. (1978). However, more efficient procedures and clearer directions need to be developed. Task appropriateness was not discussed as a criterion for training settings or levels by any of the aids. Training costs for training settings are dealt with by Collins et al. (1987).

6. Use existing situation/level decision aids for determining relative costs and refresher training intervals.

Collins et al. (1987) is recommended for use in determining relative costs. The Army's User's Manual for Predicting Task Retention (1985) is recommended for use in determining refresher training intervals.

7. Select training presentation methods based on training location, group characteristics, training events, stimulus characteristics, affective (motivational) requirements, level of difficulty, programming requirements, group practice, simulation requirements, and requirements for automation of testing and data management.

Training presentation methods should be established independently prior to the selection of training media. Training location and group characteristics should be used first to reduce the number of possible choices.

Aids that contain procedures for selecting training methods separately from training media were developed by the Marine Corps (The Marine Corps Systems Approach to Training User's Guide (Draft), 1987), the Navy (Methods/Media Selection Guidelines, 1977), and the Army (Pieper et al., 1978). However, none of these aids provides a procedure for basing media choices on the selected training methods as is recommended in this report.

An example of an aid that uses training location and group characteristics as criteria in media selection is provided by Anderson (1983). An example of an aid that varies media recommendations based on instructional events is provided by Reiser and Gagne (1982). An example of an aid that relates media selection to stimulus features is provided by Kemp (1980). Examples of aids that relate affective modes of learning in the form of motivation to training media selection are provided by Anderson (1983) and Reiser and Gagne (1983). Again, however, none of these aids apply the specified criteria to the selection of training methods as is recommended in this report.

None of the reviewed aids specify methods for dealing with retention requirements or criteria for determining where programming of instruction or automation is required.

None of the reviewed aids provide criteria for determining when group practice should be utilized. An example of an aid with criteria for use of simulations is provided by Romiszowski (1974). However, Romiszowski does not provide criteria for determining the type of simulation and the degree of fidelity required.

None of the reviewed aids provide criteria for determining if automated testing and/or data management methods are required.

8. Select training media based on training presentation methods; requirements for modification, mobility, and development time; costs; availability; and personal preferences.

As previously stated, aids that provide procedures for selecting training presentation methods separately from training media were developed by the Marine Corps (The Marine Corps Systems Approach to Training User's Guide (Draft), 1987), and the Army (Pieper et al., 1978). However, none of these aids provide procedures for basing media choices on the selected training methods as recommended in this report.

Practical requirements such as ease of revision, mobility of training devices, and development time are mentioned in several media selection aids. However, none of the reviewed aids provide detailed guidance as to which media systems best satisfy these requirements.

Two types of cost data have been provided by the media selection aids reviewed in this report, comparative and exact. Comparative cost data are useful for making rough estimates concerning the relative expense of different media (e.g., high, medium, or low). Good examples of comparative cost matrices have been provided by Lonigro and Eschenbrenner (1973). Exact cost data are typically difficult to procure and require considerable knowledge with respect to the characteristics of the training facilities, maintenance requirements, travel requirements, etc. A good example of an exact cost model for media selection is provided by Braby et al. (1975).

The availability of media and the personnel preference of the user are obvious criteria that need no examples or discussion.

9. Consider a combination of training presentation methods and media for teaching each task.

None of the aids considered requirements for mixes of training methods. Aids that consider requirements for mixes of media were developed by Braby et al. (1975), Gagne and Briggs (1974), Goodman (1971), Holden (1974), Kemp (1980), Kribs et al. (1983), Leiblum (1980), Merrill and Goodman (1972), the Navy (Methods/Media Selection Guidelines, 1977), Reiser and Gagne (1983) and Romiszowski (1974).

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